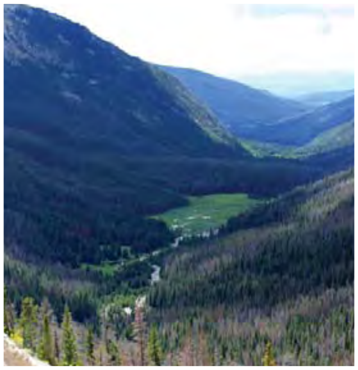
Rocky Mountain National Park

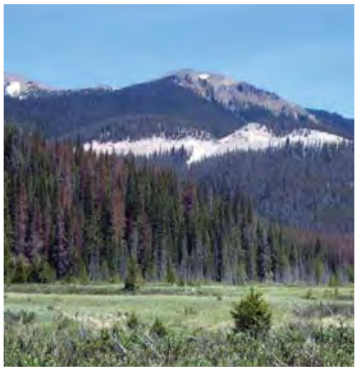
Colorado

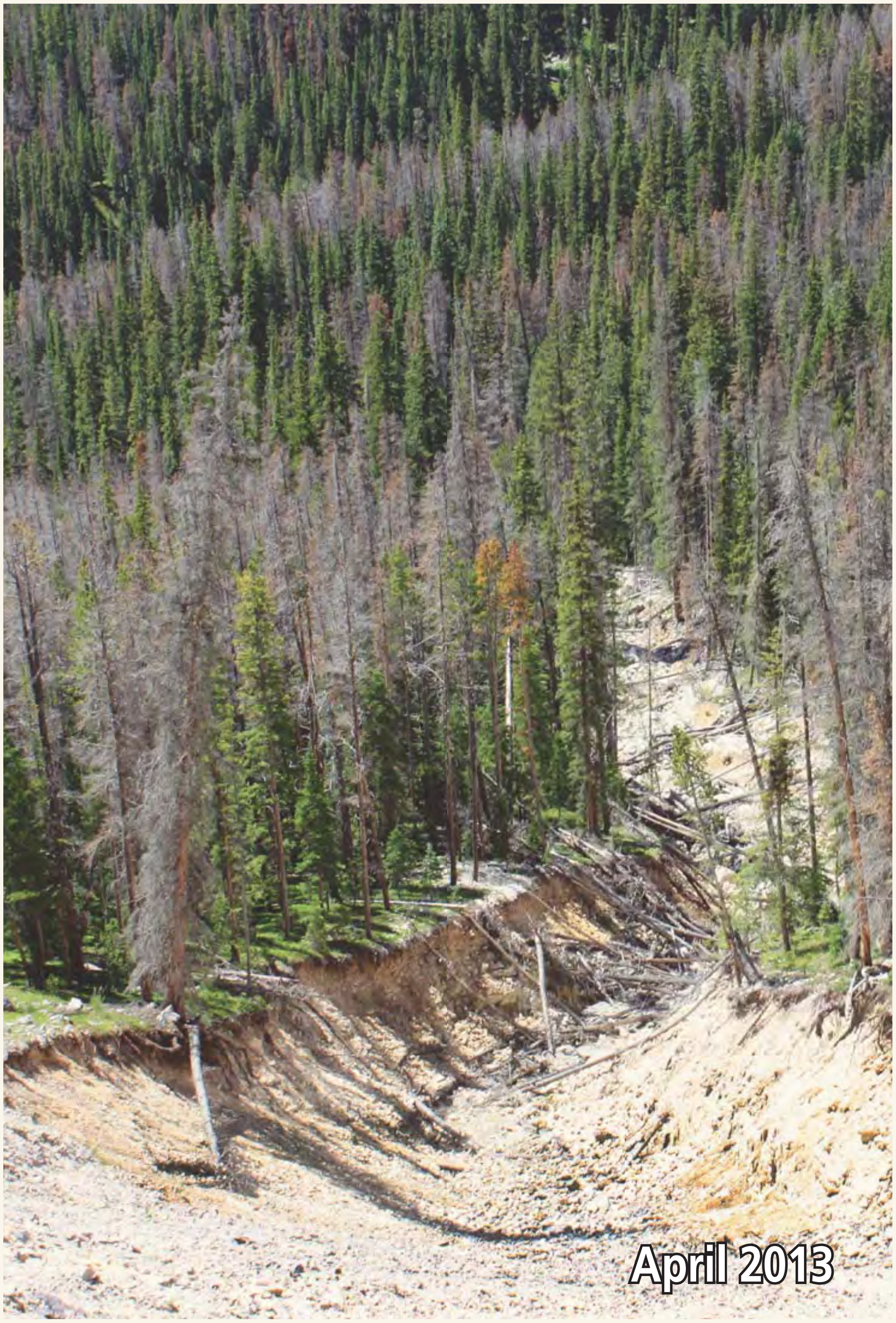
National Park Service
U.S. Department of the Interior

GRAND DITCH BREACH RESTORATION

FINAL Environmental Impact Statement







April 2013

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Final

Grand Ditch Breach Restoration Environmental Impact Statement

Rocky Mountain National Park

Colorado

This Final Grand Ditch Breach Restoration Environmental Impact Statement analyzes five alternatives to guide restoration of the area within Rocky Mountain National Park that was impacted by the 2003 Grand Ditch breach. The purpose of this environmental impact statement is to guide management actions in the park to restore the hydrological processes, ecological services, and wilderness character of the area in the Upper Kawuneeche Valley impacted by the 2003 Grand Ditch breach.

- Alternative A, the alternative of no action / continue current management, would continue current management of the impacted area, following existing management policies and NPS guidance. This alternative serves as a basis of comparison for evaluating the action alternatives.
- Alternative B, minimal restoration, would emphasize a smaller scale of management activity, compared with the other action alternatives, to restore portions of the impacted area. This alternative would focus actions on areas that are unstable and present a high potential of continued degradation of existing ecosystem resources and services. Management activities would be conducted using hand tools to reduce impact on wilderness character. This alternative would include stabilization of zone 1A, the road-cut hillside immediately below the Grand Ditch, under one of two stabilization options.
- Alternative C, high restoration, would involve more intensive management actions over large portions of the impacted area. This alternative would focus actions on unstable areas that present a high to moderate potential of continued degradation of existing ecosystem resources and services. Restoration methods would be used to stabilize banks, slopes, and disturbed areas and to lessen the availability of breach debris and sediments to the system over a larger portion of the project area. This alternative would involve the use of heavy equipment and possibly reusing excavated debris for restoration and stabilization actions both within and between zones. This alternative would include stabilization of zone 1A under one of two stabilization options.
- Alternative D is the NPS preferred alternative. This alternative would emphasize the removal of large debris deposits in the alluvial fan area and in the Lulu City wetland. Actions would be conducted to stabilize limited areas of unstable slopes and banks throughout the upper portions of the restoration area. Hydrology through the Lulu City wetland would be restored in the historical central channel through removal of large deposits of debris, relying on the historical channel to transport river flow. Small-scale motorized equipment would be employed for stabilization and revegetation activities, while larger equipment would be employed for excavation of large debris deposits and reconfiguration of the Colorado River through the Lulu City wetland. This alternative would include stabilization of zone 1A under the NPS preferred option, option 1.
- Alternative E, maximum restoration, would involve extensive management activity and use of motorized equipment over large portions of the impacted area to restore the project area to reflect both pre-breach and desired historical conditions. Extensive

recontouring and stabilization of 2003 debris deposits along banks and slopes would be conducted to approximate pre-breach contours and to reduce transport of sediments over a larger portion of the impacted area. Extensive changes would be made to both the existing and historical Colorado River channels to route the river to its historical alignment through the center of the Lulu City wetland. To facilitate movement of heavy mechanized equipment and excavated debris from the wetland to upland disposal areas, a temporary haul road would be constructed. This alternative would include stabilization of zone 1A under one of two stabilization options.

The potential environmental consequences of the actions are evaluated for each alternative, including impacts on wilderness character, natural soundscape, geology and soils, water resources, wetlands, vegetation, special status species, wildlife, cultural resources, visitor use and experience, and park operations. Short-term, adverse impacts on natural soundscape, wilderness, water resources, wetlands, visitor use and experience, and wildlife that range up to major would result from restoration activities and the use of mechanized equipment. Up to long-term, moderate to major benefits would accrue for wilderness character, wetlands, vegetation, special status species, cultural resources, and visitor use and experience under alternatives C, D, and E as a result of a high level of restoration of ecological reference conditions within a 100-year period.

EXECUTIVE SUMMARY

This Final Grand Ditch Breach Restoration Environmental Impact Statement analyzes a range of alternatives and management actions for restoration of the area within Rocky Mountain National Park that was impacted by the 2003 Grand Ditch breach. This environmental impact statement assesses the impacts that could result from continuation of the current management framework (alternative A) or implementation of one of the four action alternatives.

Development of this environmental impact statement involved the cooperation of Grand County, Colorado and the National Park Service. The National Park Service is the lead agency and is responsible for all aspects of developing the environmental impact statement, including selection of an NPS preferred alternative and preparing a record of decision. This project will be implemented by the National Park Service inside Rocky Mountain National Park.

PURPOSE OF AND NEED FOR ACTION

The purpose of this project is to restore the natural hydrological processes, ecological services, and wilderness character of the area in the Upper Kawuneeche Valley impacted by the 2003 Grand Ditch breach. Implicit in this purpose is that the ecosystems restored are naturally dynamic and self-sustaining. The project area includes portions of Lulu Creek, the Colorado River, and the Lulu City wetland.

The National Park Service is obligated by law and policy to maintain and restore, to the extent possible, the natural conditions and processes in park units (NPS 2006a, section 4.1.5). The Upper Kawuneeche Valley area of impact contains more sediment, debris, and subsequent injuries from the 2003 Grand Ditch breach than it would under natural conditions. The breach has resulted in highly unnatural conditions within the project area as a large amount of excess sediment has been deposited into the system and remains in an unstable, erodible state. The estimated 47,600 cubic-yard debris flow from the 2003 breach resulted in channel morphologic changes, deposition of a large debris fan, increased sedimentation along the Colorado River, altered aesthetics of a wilderness area, and tree mortality and scarring. These impacts have degraded the aquatic, riparian, and upland ecosystems, in addition to the wetland communities that support a unique array of species in comparison to other habitat types in the park.

NPS *Management Policies* direct managers to strive to maintain the components and processes of naturally evolving park ecosystems (NPS 2006a). These policies also recognize that if biological or physical processes were altered by human activities, they may need to be actively managed to restore them to a natural condition or to maintain the closest possible approximation of the natural condition.

OBJECTIVES

Objectives are specific statements of purpose; they describe what must be accomplished, to a large degree, for the project to be considered a success. The following objectives for restoring the area impacted by the 2003 Grand Ditch breach were developed by the planning team and will be used as a measure of performance of the alternatives in the environmental impact statement. For the purposes of this environmental impact statement, restoration is defined as "correcting resource interactions that function unnaturally and ensuring that the directions of the recovery processes are along the proper trajectory, rather than attempting to recreate the end state of an unimpaired natural system" (NPS 2011k).

- Restore appropriate stream hydrological and groundwater processes
- Restore appropriate native plant communities
- Restore the stability of the hillside below the breach site
- Restore wilderness character
- Restore wildlife habitat
- Restore aquatic habitat
- Restore water quality in the affected area and downstream

IMPACT TOPICS ANALYZED

Individual impact topics, or subject resources, were analyzed in this environmental impact statement to determine potential effects that would occur as a result of implementation of any of the alternatives presented in this environmental impact statement. The impact topics and the rationale for fully evaluating the particular topic are presented below.

Wilderness character: Retained because of the potential for restoration actions to affect designated wilderness in the park.

Natural soundscape: Retained because it could be affected by installation and execution of several of the potential restoration activities. These include, but are not limited to, construction equipment and the use of vehicles and aircraft.

Geology and soils: Retained because of the impacts that the 2003 breach had and continues to have on geology and soils in the Upper Kawuneeche Valley.

Water resources: Retained because of the relationships among vegetation, water resources, wetlands, and debris flows from the 2003 breach. This topic also addresses wetland issues associated with hydrology.

Wetlands: Retained because much of the area of impact in the Upper Kawuneeche Valley consists of wetlands and floodplains.

Vegetation: Retained as one of the primary resources to be restored by this project. This impact topic will include analyses of effects on upland, riparian, and wetland vegetation.

Special status species: Retained because actions taken by the project could have effects on several listed species and must be evaluated for compliance with the Endangered Species Act.

Wildlife: Retained because of the potential of the project to affect other terrestrial and aquatic species of wildlife and their habitats.

Cultural resources: Retained because the breach may have affected historic structures and archeological resources within the project area. Alternatives will need to be evaluated for their potential to affect these resources.

Visitor use and experience: Retained because implementation of restoration activities would impact visitor access and experience within the Upper Kawuneeche Valley. The actions implemented by the project could affect how visitors would experience this area of the park.

Park operations: Retained because the implementation of restoration activities in association with this project would require temporary changes in how this area of the park is operated.

PURPOSE OF AND SIGNIFICANCE OF ROCKY MOUNTAIN NATIONAL PARK

National park system units are established by Congress to fulfill specific purposes, based on the unit's unique and "significant" resources. A unit's purpose, as established by Congress, is the foundation on which later management decisions are based to conserve resources while providing "for the enjoyment of future generations."

Establishment

Congress established Rocky Mountain National Park on January 26, 1915. The enabling legislation states (38 Stat. 798)

> Said area is dedicated and set apart as a public park for the benefit and enjoyment of people of the United States…with regulations being primarily aimed at the freest use of the said park for recreation purposes by the public and for the preservation of the natural conditions and scenic beauties thereof…

Significance of Rocky Mountain National Park

As stated in the park's 2005–2008 strategic plan (NPS 2005b), Rocky Mountain National Park is significant because

> Rocky Mountain National Park provides exceptional accessibility to a wild landscape with dramatic scenery, opportunities for solitude and tranquility, wildlife viewing, and a variety of recreational opportunities.
>
> The fragile alpine tundra encompasses one third of the park and is one of the main scenic and scientific features for which the park was established. This is one of the largest examples of alpine tundra ecosystems preserved in the national park system in the lower 48 states.
>
> The park, which straddles the Continental Divide, preserves some of the finest examples of physiographic, biologic, and scenic features of the Southern Rocky Mountains. The park contains the headwaters of several river systems, including the Colorado River. Geologic processes, including glaciation, have resulted in varied and dramatic landscape. Elevations span from 7,630 feet to 14,259 feet atop Longs Peak, a landmark feature.
>
> The park's varied elevations encompass diverse ecosystems where wilderness qualities dominate. Varied plant and animal communities and a variety of ecological processes prevail.

In October 1976, Rocky Mountain National Park was recognized as an International Biosphere Reserve. This recognition highlights the significance of the park's natural ecosystems, which represent the Rocky Mountain Biogeographic Province. As an element of the Biosphere Reserve, Rocky Mountain National Park is part of a network of protected samples of the world's major ecosystem types, devoted to conservation of nature and genetic material and to scientific research in service of man.

ALTERNATIVES

This environmental impact statement evaluates five alternatives that could be implemented to manage restoration of the area within Rocky Mountain National Park that was impacted by the 2003 Grand Ditch breach. The four action alternatives have the following elements in common:

- **Vegetation Restoration** – The restoration of vegetation within the project area would occur to varying degrees under each of the alternatives. Seeding with native seed would be used primarily in the upper zones of the disturbed area and small trees and shrub species would be placed in some locations.

  In the wetland locations, sprigs of sedges or cuttings of tall willows would be planted, depending upon the alternative. Sprigs of sedges would be grown by a contract nursery from seed collected from existing wetlands in the project vicinity to maintain the genetic integrity of the wetland plant communities. All plant material used in the restoration effort would need to meet the genetic similarity requirements of the park's current vegetation restoration management plan. Revegetation of disturbed soil areas would be facilitated by salvaging and storing existing topsoil and reusing it in restoration efforts in accordance with NPS policies and guidance. In addition to these actions, the National Park Service would continue to treat and manage exotic or nonnative plant species in the project area in compliance with the park's exotic plant management plan (NPS 2003b).

- **Restoration Implementation** – Restoration activities would be conducted in the summer after the peak runoff and before significant snowfall. The timeframe would generally be June through September. Restoration activities would take place during daylight hours throughout the week as needed. The duration of restoration activities varies by alternative. Work crews would be housed in the project area when possible to minimize travel into and out of the area.

- **Minimum Requirement Analysis** – All action alternatives, including some of the slope stabilization in zone 1A, would involve activities in designated wilderness areas within the park. Therefore, in accordance with the Wilderness Act and NPS policies, the National Park Service must complete a minimum requirement analysis before taking management actions. This discussion analyzes whether management actions affecting wilderness character are necessary and is appended to this environmental impact statement in appendix F.

- **Resource Monitoring** – The effectiveness of specific restoration actions and resource conditions would be monitored over the next 20 years, and longer if deemed necessary. Changes in stream and groundwater hydrology, channel morphology, water quality, and vegetative recovery would be monitored in the restoration area to measure restoration effectiveness. Monitoring would also evaluate mitigation measures and best management practices for effectiveness in reducing adverse effects on resources.

- **Education –** Under all action alternatives, public education efforts would be developed to provide information about the restoration action taking place in the project area. The education component of the project could include interpretive programs about the resource issues and restoration, articles, annual reports on restoration efforts and research activities, postings on the park and NPS websites, and wayside signs describing the restoration efforts at trailheads near the project area.
- **Mitigation Measures and Best Management Practices –** Impact avoidance and mitigation measures refer to measures and practices adopted by a project proponent to reduce or avoid adverse effects that could result from restoration activities. The Council on Environmental Quality recommends consideration of five types of mitigation measures: avoiding, minimizing, rectifying, reducing, and compensating (40 *Code of Federal Regulations* [CFR] 1508.20). To ensure that implementation of the action alternatives protects natural and cultural resources and the quality of the visitor experiences, mitigation measures that are typical for this type of proposed restoration project have been identified for each action alternative.

In addition to each of these elements, each action alternative considers bank stabilization to some degree. Bank stabilization refers to reshaping banks and, to some degree, placing rocks or other available materials (e.g., cobbles or large woody debris) to lessen the availability of breach debris and sediments to the system. Reshaping banks also allows riparian vegetation to establish more quickly. The park service recognizes the dynamic nature of streams, and it is not the intent of the alternatives to lessen changes to the stream channels as a result of natural processes such as erosion. Rather, it is the goal of the restoration action to prevent unnatural amounts of debris and sediment resulting from the breach to be transported downstream and to allow for the channels to migrate laterally as would occur under natural conditions.

The following alternatives are proposed for managing restoration of the area within Rocky Mountain National Park that was impacted by the 2003 Grand Ditch breach:

Alternative A, No Action Alternative / Continue Current Management

Under alternative A, the National Park Service would continue current management of the impacted area, following existing management policies and NPS guidance. The park would not undertake any active restoration but would continue to rely on natural processes to restore the hydrologic conditions and biotic integrity of the area.

Zone 1A – Under this alternative, no stabilization would occur within zone 1A. This alternative would likely violate the court mandate to stabilize this area as stipulated in the 2008 settlement between the United States and the Water Supply and Storage Company.

Alternative B, Minimal Restoration

Alternative B would emphasize a smaller scale of management activity, compared with the other action alternatives, to restore portions of the impacted area. This alternative would focus actions on areas that are unstable and present a high potential of continued degradation of existing ecosystem resources and services. Management activities would be conducted using hand tools to reduce impact on wilderness character. There would be no active management to change the hydrologic conditions under this alternative, and the National Park Service would instead rely upon natural processes to restore the hydrologic channel stability condition in the stream channels and wetland areas.

Zone 1A – Under alternative B, the following two options would be considered for stabilization of zone 1A.

- Option 1 – This option includes the use of a tie-back anchoring system to stabilize the slope in zone 1A. Under option 1, the slope would be smoothed to help blend the over-steepened slopes on the lateral edges of the scar into the surrounding slope and remove unstable rocks on the slope surface, reducing the erosion potential of sharp slope edges. The damaged area would be stabilized using soil-nail anchors that would be installed through the unconsolidated fill. Steel mesh would then be installed over the slope face and anchored to the soil nails to prevent raveling of materials. Specific surface treatments such as geocell installation or rock mulching may be required in critical locations to control shallow, surficial flow slides and provide erosion protection for the recently placed fill slopes. Installation of a reinforced earth cap along the ditch road would help maintain surface drainage away from the crest and reduce raveling of slope face materials.
- Option 2 – This option would stabilize the slope using rock buttresses and by back-filling the gully to achieve pre-breach slope contours. Under option 2, a toe buttress would be constructed at the toe of the existing fill slope to act as a berm for the fill placement. Compacted fill consisting primarily of silty gravels would be placed on the upstream side of the toe buttress up to the crest of the buttress to provide the first horizontal work platform for the placement of foundation anchors (rock bolts and/or soil nails). Slope reinforcing geogrid material could then be attached to these anchors and laid horizontally on top of the compacted work platform. Fill material would be obtained from a commercial source. The previous step would then be repeated through placement of a layer of compacted backfill on top of the geogrid material up to approximately the existing invert level of the ditch. In addition, a growth media cover, up to 2 feet thick, would be placed on the face of the compacted fill. This cover would be vegetated as part of the long-term stabilization of the fill with a suitable seed mixture.

Alternative C, High Restoration

This alternative would involve more intensive management actions over large portions of the impacted area and would focus actions on unstable areas that present a high to moderate potential of continued degradation of existing ecosystem resources and services. Restoration methods would be used to stabilize the 2003 debris deposits along banks and slopes and to lessen the availability of breach debris sediments to the system over a larger portion of the project area. This alternative would actively restore the hydrologic conditions in large portions of the impacted area by removing sediment from the 2003 breach and additional historical unnatural debris deposits in the Lulu City wetland as needed to restore wetland functions, by constructing and enhancing step pools and pool-riffle complexes, and by reconnecting the Colorado River with the floodplain in localized areas. This alternative would involve the use of heavy equipment and possibly reusing excavated debris for restoration and stabilization actions both within and between zones. The conceptual design for this alternative represents basic hydraulic engineering requirements to ensure that flows are naturally conveyed within the stream channel cross sections of the Colorado River through the Lulu City wetland (zone 4) and that the channels would maintain hydrologic function. A tall willow community would be restored to areas where sediment would be removed. These willows would be protected with a tall fence enclosure designed to exclude browsing pressure from elk and moose.

Zone 1A – Stabilization of the slope within this zone would be accomplished using either option 1 or option 2, as described under alternative B.

Alternative D, the National Park Service Preferred Alternative

This alternative would emphasize the removal of large debris deposits in the alluvial fan area and in the Lulu City wetland. Actions would be conducted to stabilize limited areas of unstable slopes and banks. In the upper portions of the restoration area, stabilization actions would be implemented in areas with steep slopes, where vegetation has not reestablished since the breach. The debris deposited in the alluvial fan would be removed, sediment would be removed in localized areas along the Colorado River to reconnect the river with some previously blocked floodplain locations, and sediment from the 2003 breach and additional historical unnatural debris deposits would be removed as needed to restore wetland functions in the Lulu City wetland. Hydrology through the Lulu City wetland would be restored in the historical central channel through removal of large deposits of debris, relying on the historical channel to transport river flow. Small-scale motorized equipment would be employed for stabilization and revegetation activities, while larger equipment would be employed for excavation of large debris deposits such as in the Lulu City wetland. The conceptual design for this alternative represents basic hydraulic engineering requirements to ensure that flows are naturally conveyed within the stream channel cross-sections and that the channels would maintain hydrologic function. A tall willow community would be restored to areas where sediment would be removed. These willows would be protected with a tall fence enclosure designed to exclude browsing pressure from elk and moose.

Zone 1A – Stabilization of the slope within this zone would be accomplished using option 1, as described under alternative B.

Alternative E, Maximum Restoration

This alternative would involve extensive management activity and use of motorized equipment over large portions of the impacted area to restore the area to reflect both pre-breach and desired historical conditions. Extensive recontouring and stabilization of 2003 debris deposits along banks and slopes would be conducted to approximate pre-breach contours and to reduce transport of sediments over a larger portion of the impacted area. Extensive changes would be made to both the existing and historical Colorado River channels to route the river to its historical alignment through the center of the Lulu City wetland. This alternative would actively restore the hydrologic conditions by removing debris deposits resulting from the 2003 breach and additional historical unnatural debris deposits. Debris would be reused in the restoration and stabilization actions both within and between zones. To facilitate movement of heavy mechanized equipment and excavated debris from the wetland to upland disposal areas, a temporary haul road would be constructed. The conceptual design for this alternative represents basic hydraulic engineering requirements to ensure that high flood flows are naturally conveyed within the stream channel cross sections and that the channels would maintain hydrologic function. A tall willow community would be restored to areas where sediment would be removed. These willows would be protected with a tall fence enclosure designed to exclude browsing pressure from elk and moose.

Zone 1A – Stabilization of the slope within this zone would be accomplished using either option 1 or option 2, as described under alternative B.

PROCESS TO IDENTIFY THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

The Council on Environmental Quality regulations for implementing National Environmental Policy Act (40 CFR 1502.14[e]) require that an agency identify its preferred alternative or alternatives in draft and final EIS documents. The NPS preferred alternative is that alternative "which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors" (46 Federal Register 18026, Q4a).

Identification of the NPS preferred alternative is based on the overall ability of the alternative to resolve the need for the plan, meet the project objectives to a high degree, and minimize adverse effects on the resources of the park. Although all of the action alternatives would meet these criteria, additional factors were considered in the selection of the NPS preferred alternative. The NPS preferred alternative was developed to achieve a high level of ecological restoration based on the ecological reference conditions in a relatively short time. It also considers that restoration of ecological reference conditions is occurring naturally in some locations, such as in areas of zones 2 and 3, and that allowing passive restoration to continue would be cost effective and reduce the impacts of implementation to important resources such as wilderness. Alternative D was identified as the NPS preferred alternative. It is a composite of the other action alternatives that combines the most effective actions that could be accomplished within the project budget. Alternative D improves ecological processes and biodiversity, which is achieved in large part by restoring the Lulu City wetland in Zone 4. Restoration in the wetland would involve debris removal, planting of tall willow, and actively restoring hydrologic processes, including return of the Colorado River channel to the center of the wetland. In the project area, willows would be protected with a tall fence enclosure designed to exclude browsing pressure from elk and moose. Hydrologic recovery and restoration of historical fluvial processes would be more complete and take less time by removing more debris in the Lulu Creek alluvial fan and in zone 4 and, in some areas where it may be disconnected, by reconnecting the river channel to the floodplain in zone 3. Large improvements to wilderness character would be achieved by reducing the physical evidence of damage caused by the breach through removal of the large debris deposits in the Lulu Creek alluvial fan and restoration of the ecological and hydrologic reference conditions in the Lulu City wetland.

ENVIRONMENTALLY PREFERABLE ALTERNATIVE

The environmentally preferable alternative is the alternative that will promote the National Environmental Policy Act, as expressed in section 101 of the act. The environmentally preferable alternative is alternative E. Alternative E restores ecological processes to the greatest degree, restores and preserves wilderness characters and values over the long term, and provides the highest level of channel stability and reduced sedimentation over a greater extent of the project area.

ENVIRONMENTAL CONSEQUENCES

Impacts of the five alternatives were assessed and are presented in chapter 4 of the environmental impact statement and are summarized in table 2-8 in chapter 2.

CONTENTS

Contents (continued)

Contents (continued)

Contents (continued)

Contents (continued)

Contents (continued)

Contents (continued)

LIST OF TABLES

LIST OF FIGURES

Contents (continued)

Contents (continued)

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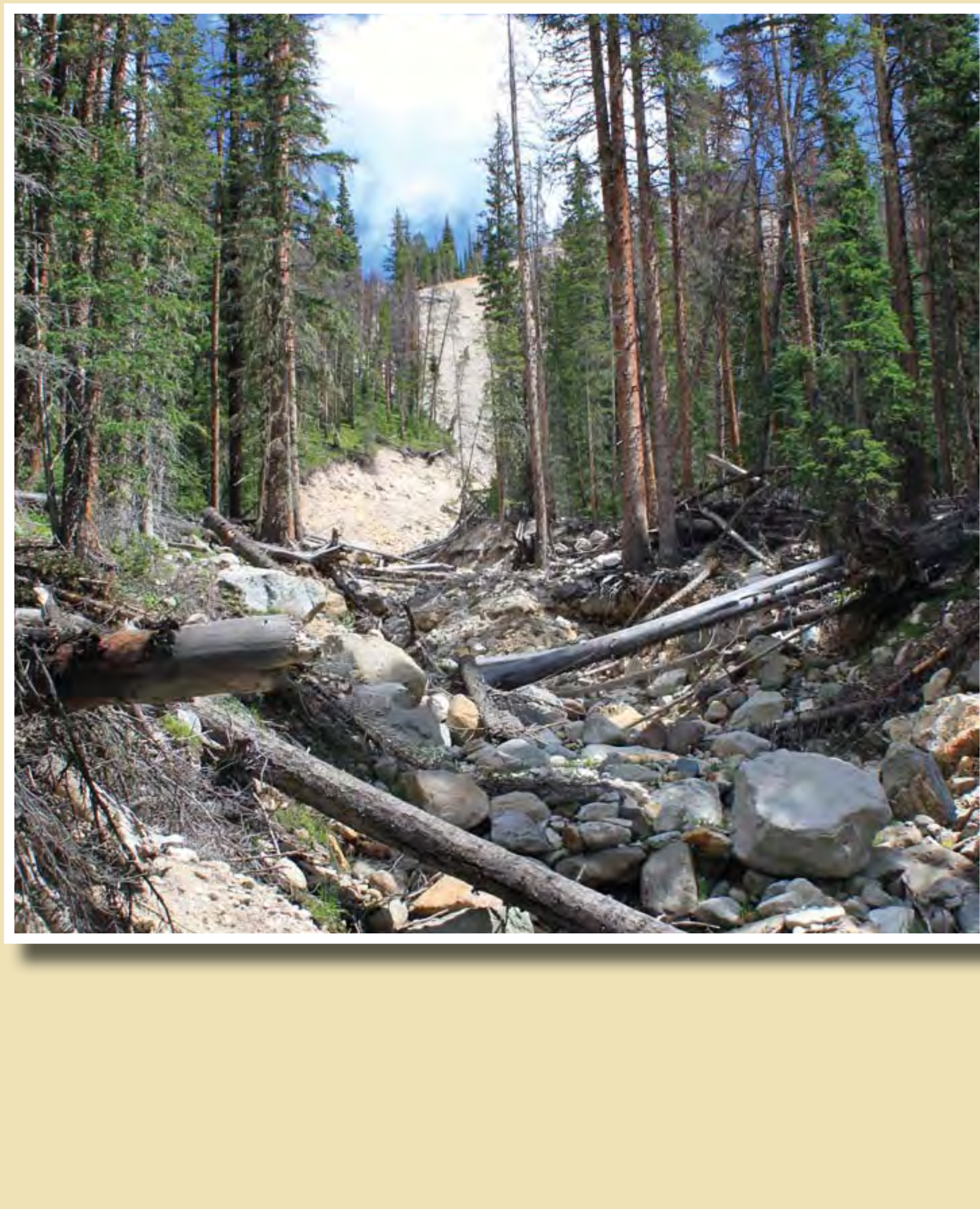
CHAPTER 1:

PURPOSE OF AND NEED FOR ACTION



INTRODUCTION

This chapter explains why the National Park Service (NPS) is taking action to evaluate a range of alternatives for restoration of the Grand Ditch breach site in the Upper Kawuneeche Valley of Rocky Mountain National Park. This *Grand Ditch Breach Restoration Environmental Impact Statement* presents four action alternatives for restoration within the area of impact of the May 30, 2003, Grand Ditch breach and assesses the impacts that could result from continuation of the current conditions or from implementation of any of the four action alternatives.

The Grand Ditch runs along the eastern slope of the Never Summer Range, within the Kawuneeche Valley, part of the uppermost portion of the Colorado River watershed (figure 1.1). On May 30, 2003, a breach along the Grand Ditch caused an overtopping of the ditch, which caused severe erosion on the hillslope below. The resulting debris flow entered Lulu Creek and continued downstream to the Colorado River. A debris fan was deposited at the confluence of Lulu Creek and the Colorado River. Evidence of extensive injury to vegetative communities and of in-channel and floodplain erosion and deposition resulting from reworking of the debris flow material is prominent for at least 1.5 miles downstream to the lower end of the Lulu City wetland.

Debris flows are mass movement that occurs when saturated rock or unconsolidated material moves rapidly downhill as a slurry. Debris flows occur naturally when rock is weakened by weathering over time, especially on steep hillslopes, or as the result of human actions that destabilize slopes (Rathburn 2007).

This environmental impact statement focuses on the area of the Upper Kawuneeche Valley impacted by this 2003 breach. The site is within designated wilderness in the northwest region of Rocky Mountain National Park (see “Zones” subsection of “Resource Damage Assessment” in this chapter). The area of impact refers to the area directly affected by the 2003 breach; it has been designated into zones 1A, 1B, 2, 3, and 4. The Grand Ditch itself is owned and operated by the Water Supply and Storage Company and has a right of way through Rocky Mountain National Park. This EIS therefore does ***not*** include any actions related to the operation, management, or repair of the Grand Ditch.

The sensitive riparian vegetative community in the Kawuneeche Valley is important habitat for many wildlife species (Cordova 2007). The vegetation has been disturbed over the past century due to various factors such as alterations in water level, debris flows, impacts from ungulate grazing, past livestock grazing before the area was a national park, and the decline of beaver populations. The plants associated with the riparian area of the upper Colorado River have become stressed, leading to their decline in both abundance and structure.

Ecological services involve a multitude of resources and processes that are supplied by natural ecosystems benefitting the biota. Collectively, these benefits are known as ecological services. Examples would include clean drinking water and nutrient cycling.

Research conducted in the park indicates that the 2003 breach has compounded these circumstances: landforms, hydrologic regime, and vegetation within the Upper Kawuneeche Valley have been highly impacted by the 2003 breach as well as by previous debris flows. The impacted area contains more sediment, debris, and subsequent damages from the Grand

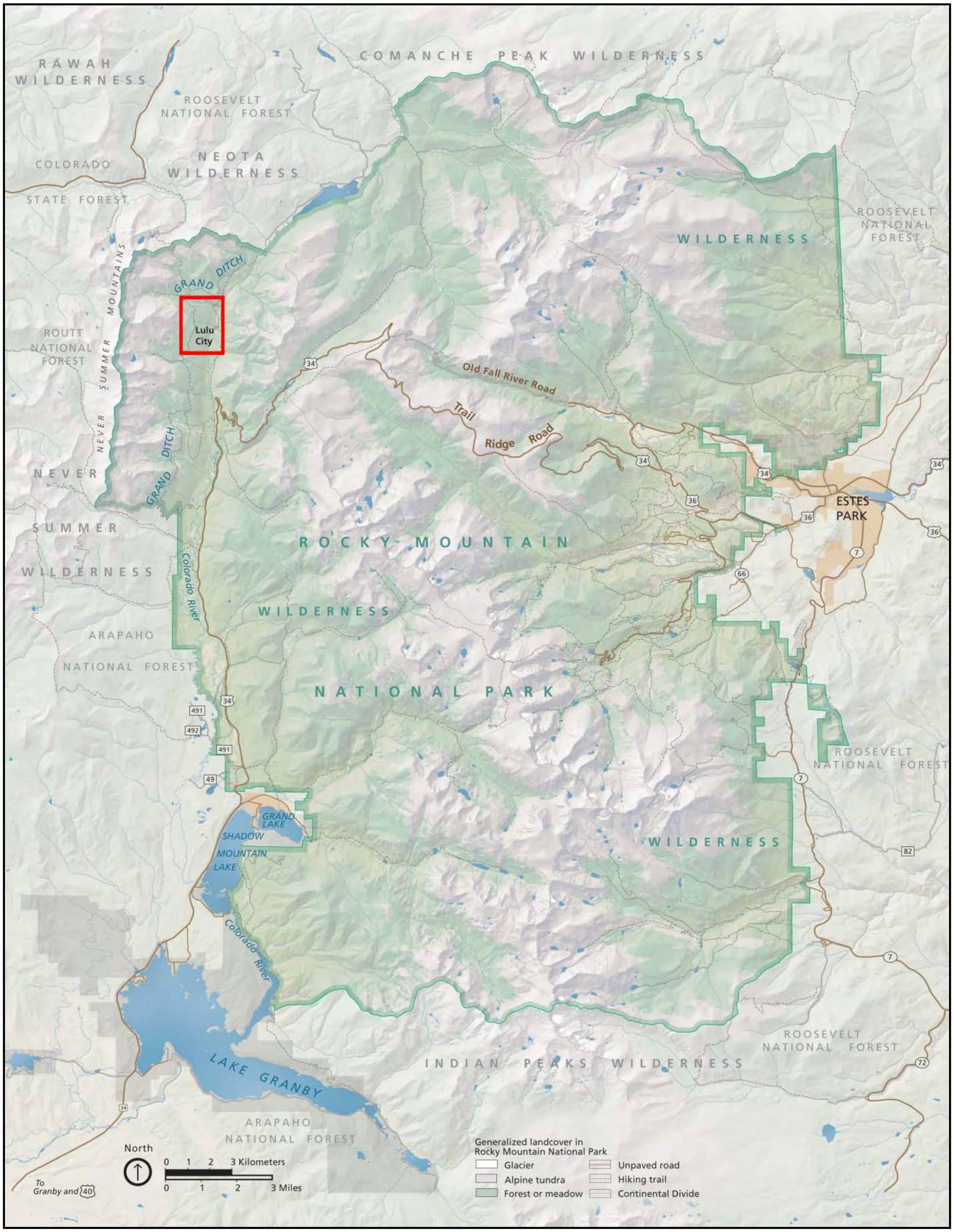


Figure 1.1: Rocky Mountain National Park and the area affected by the Grand Ditch breach

Ditch breach than it otherwise would have, affecting the ecological services of the area. One of the most prominent impacts is the alteration of the hydrologic regime and dependent plant communities in the Lulu City wetland. Other impacts include those to aquatic, riparian, and upland communities.

PROJECT BACKGROUND

THE GRAND DITCH

The Grand Ditch is a 15-mile water diversion project in the Never Summer Mountains, in the northwest region of Rocky Mountain National Park. Streams and creeks that flow from snow runoff on the eastern side of the peaks of the Never Summer Mountains are diverted into the ditch, which flows over the Continental Divide at La Poudre pass and delivers the water into the Cache La Poudre River. Construction of the ditch was started in 1890 but was not completed until 1937. The ditch diverts 20% to 40% of the summer runoff from the Never Summer Mountains, collecting the flow from 12 headwater tributaries, including Baker Creek, Red Gulch, Opposition Creek, Mosquito Creek, Lost Creek, Big Dutch Creek, Middle Dutch Creek, Little Dutch Creek, Sawmill Creek, Lulu Creek, Lady Creek, and Bennett Creek (Butler 2008). It significantly impacts the ecology in the Kawuneeche Valley below.

The ¾-mile-long Bennett Ditch was built by the Larimer County Ditch Company in 1890 from Bennett Creek to La Poudre Pass. Also in 1890, the Water Supply and Storage Company of Fort Collins began construction on the Grand Ditch. Between 1896 and 1904, the ditch was extended 5 miles from Bennett Creek to Big Dutch Creek and by 1911 to Mosquito/Opposition Creeks. Construction was carried out intermittently, and a series of camps established along the route between 1890 and 1911 housed workers and equipment. Work on the ditch ceased in 1911 but resumed in 1934 when the ditch company decided to extend the ditch to Baker Gulch to maintain water rights. An increasing demand for water led to the creation of Long Draw Reservoir, which opened in 1930; a seventh ditch construction camp was erected at that time but remained unused until ditch construction restarted in 1934. The last seven miles of the ditch were completed with heavy machinery, with work finished in 1937 (Butler 2008).

The amount of water the Grand Ditch transfers to the Cache la Poudre is estimated to be 30,000 acre-feet annually (Butler 2008). Water diverted through the ditch is currently used for agricultural irrigation; however, more than 60% of the Water Supply and Storage Company stock is owned by water providers, including the cities of Fort Collins, Greeley, and Thornton (Mars 2010).

An **acre-foot** is the volume of water required to cover 1 acre of land (43,560 square feet) to a depth of 1 foot. It equals 325,851 gallons or 1,233 cubic meters.

THE BREACH

The breach involved a 100-foot section of the Grand Ditch about 2.4 miles south of La Poudre Pass (figure 1.2). Water from the ditch flowed for several days, sending a torrent of water, soil, rocks, trees, and other vegetation toward the Colorado River. The breach saturated an adjacent steep hillslope that gave way, sending a massive slide of mud and rocks down into Lulu Creek and the headwaters of the Colorado River, damaging upland, stream, riparian, and wetland habitat.

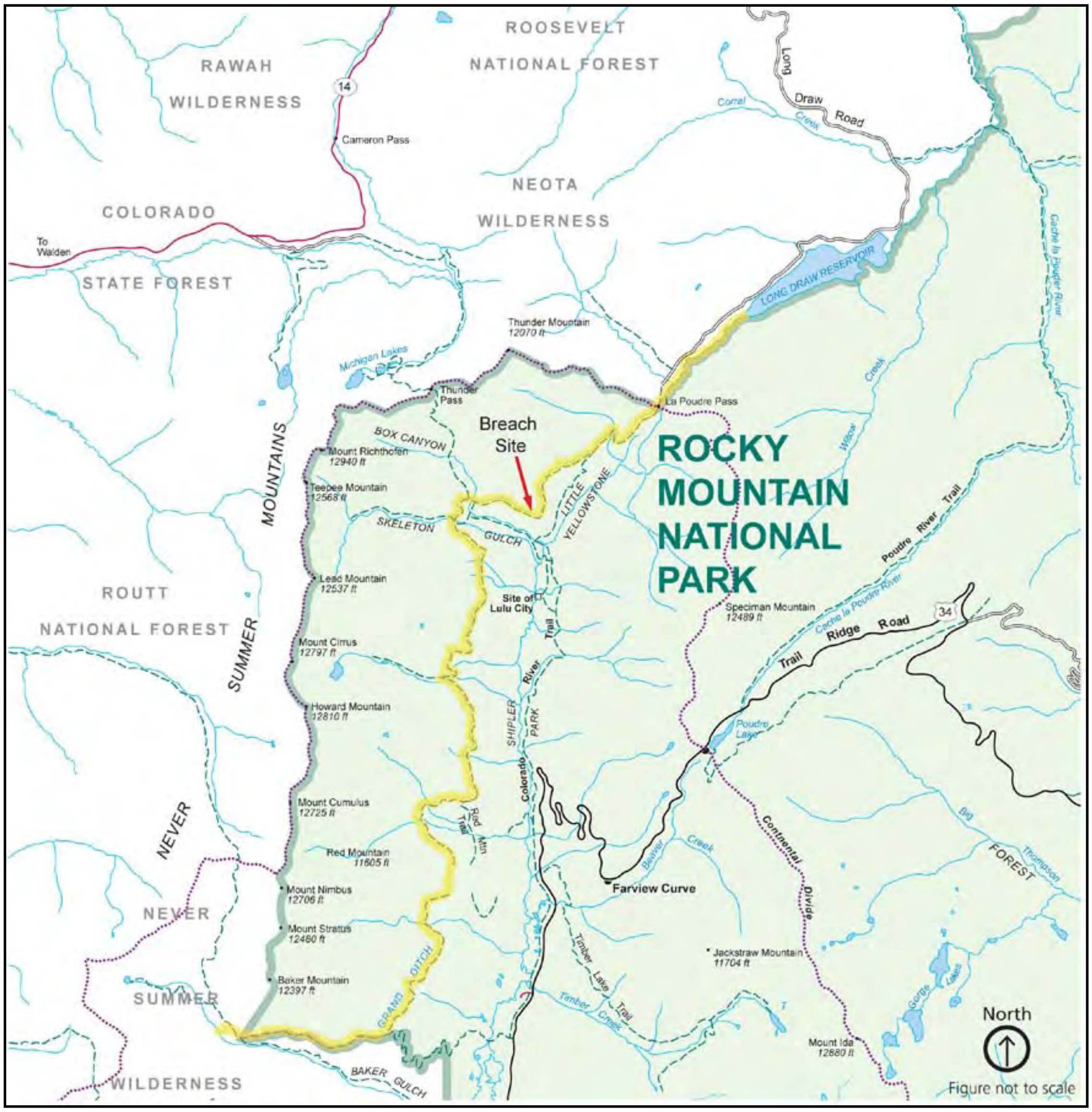


Figure 1.2: Location of the Grand Ditch

The actual cause of the Grand Ditch's failure is uncertain. It may have overtopped or it may have formed a seep that collapsed the ditch sidewall, sending an estimated 100 to 200 cubic feet per second of water from the ditch down a steep hillside (figure 1.3), with an estimated 47,600 cubic yards (around 5,000 dump truck loads) of boulders, trees, and sediment cascading into Lulu Creek.

Lulu Creek flowed as a mud- and debris-filled torrent, gouging the streambed nearly 7 feet deep, widening the channel by as much as 10 times and uprooting and depositing piles of trees and sediment throughout. When the torrent arrived at the low-gradient confluence with the Colorado River, it deposited sediment and debris in an alluvial fan up to 6 feet thick. The sediment-filled waters continued downstream along the Colorado River, clogging the channel and covering the floodplain with gravel, sand, and more debris (figure 1.4).

About 1 mile farther downstream, the flood filled the existing channels of the Lulu City wetland and deposited up to 2 feet of silty sand onto the wetland, burying the existing vegetation and altering the wetland's hydrologic regime.

Finer sediments were transported an additional 27 river miles downstream to Shadow Mountain Lake, where a visible delta formed. In all, approximately 22 acres and 1.5 miles of stream, riparian, upland, and wetland habitat were injured. Over 20,000 trees were destroyed and about 50 different plant species were impacted.

Figure 1.3: Looking up at the breach site (Zone 1A)

Figure 1.4: Grand Ditch breach area in the Upper Kawuneeche Valley within Rocky Mountain National Park

THE SETTLEMENT

In 2006, the U.S. Department of Justice, on behalf of the United States, filed a civil lawsuit against the Water Supply and Storage Company, owners of the Grand Ditch, under the authority of the Park System Resource Protection Act, which allows the United States to seek compensation from parties responsible for injuring park resources.

In May 2008, an out-of-court settlement was reached in which the Water Supply and Storage Company agreed to pay the United States $9 million in damages.

Per the settlement, the National Park Service and the Water Supply and Storage Company will cooperate in the planning for any stabilization activities on the slope below the Grand Ditch at the location of the May 30, 2003, breach within zone 1A.

The National Park Service has an interest in ensuring that zone 1A is stabilized and in preventing further damage to Rocky Mountain National Park. The Water Supply and Storage Company has an interest in ensuring that repairs undertaken in zone 1A provide sufficient and appropriate support so that operations and/or repairs to the Grand Ditch, or the ditch road after the repairs are completed, can be carried out without significant future risk of ditch or road failure. Stabilization in zone 1A means that under normal precipitation patterns, small amounts of erosion may occur, but there would be no wasting of the hillside resulting in transportation of large amounts of sediment into the project area. Because the United States has stated its intention to stabilize zone 1A within the settlement, zone 1A must be stabilized under any of the proposed action alternatives.

RESOURCE DAMAGE ASSESSMENT

Rocky Mountain National Park and a team of cooperating researchers conducted surveys, starting in the summer of 2003, to assess the nature and extent of the injury caused by the breach. Assessment work focused primarily on defining the footprint and the approximate depth of the deposited materials while characterizing stream morphology, groundwater elevations, water quality, and impacts on wetland, riparian, and upland vegetation. The stability of the gouge in the steep hillside immediately below the breach site was also investigated.

Initial research concluded that the natural resource damages to the channels and associated features from the spring 2003 ditch failure include (1) channel morphologic changes, including channel avulsions, that altered the character of Lulu Creek substantially and the Colorado River to a lesser extent; (2) deposition of a large debris fan at the confluence of Lulu Creek and the Colorado River; (3) increased sedimentation along the Colorado River, which provides important aquatic habitat for organisms and vegetation; (4) altered aesthetics of the area due to heavy erosion and deposition, especially in areas adjacent to hiking trails within Rocky Mountain National Park, and (5) tree mortality and scarring along the length of the study reach (Rathburn 2007).

Since the 2008 settlement, additional assessment work has been conducted by researchers (such as Dr. Sara Rathburn and Dr. David Cooper) from Colorado State University and the park to refine understanding of the area's current hydrology, including stream hydrology, sediment transport, surface water-groundwater interactions, wetland functions, and groundwater elevations. These processes are being compared with nearby reference reaches to facilitate development of reference conditions for the impacted area. Also, ground-penetrating radar was used to map sediment deposit depths. This information is being used to design restoration that will, per the Park System Resource Protection Act, "restore, replace, or acquire the equivalent of resources which were the subject of the action." The Park System Resource Protection Act is described further in the Relevant Laws, Policies, and Constraints section of this chapter.

Zones

The area of impact was analyzed by the approximate extent of deposition and injury to vegetation caused by the Grand Ditch breach. The injured area is divided into four zones representing different geo-ecological areas (figure 1.5, and figures 2.3 – 2.7, for example).

Zone 1 is the steep, gullied hillside immediately below the breach site to the point where a perennial stream surfaces above Lulu Creek.

> *Zone 1A* is the bare, road-cut hillside immediately below the Grand Ditch. This area was previously disturbed during construction of the ditch.
>
> *Zone 1B* is the once-forested hillside below zone 1A.

Zone 2 is the active channel where a perennial stream surfaces and flows into Lulu Creek to the confluence of Lulu Creek with the Colorado River.

Zone 3 includes the Colorado River from its confluence with Lulu Creek (zone 2) downstream to the Lulu City wetland (zone 4).

Zone 4 is the section of the Lulu City wetland impacted by the breach.

Injury by Zone

As defined by Dr. David J. Cooper (2007b), injuries within each zone caused by the 2003 Grand Ditch breach include the following:

Zone 1 (Including zone 1A and zone 1B). The breach resulted in the erosion of approximately 47,600 cubic yards from the hillslopes below the breach. This created a large gully with steep and unstable sides. Prior to the breach, the slopes below the previously disturbed ditch were vegetated by upland forest. The forest floor was largely dominated by grouse whortleberry (*Vaccinium scoparium*).

Within zones 1A and 1B, the total area of disturbance is approximately 2.3 acres; however, approximately 1.0 acre was previously disturbed by activities associated with the Grand Ditch. Significant tree loss in this zone resulted in a 100% loss of ecological services of upland habitat, including wildlife habitat, soil stability, and aesthetic quality (Cordova 2006; Peacock 2007). For further discussion on impacts on zone 1, please reference appropriate sections of chapter 3, "Affected Environment."

Zone 2. The landforms, hydrology, and vegetation in zone 2 were impacted by the Grand Ditch breach. The vegetation within zone 2 was characterized by upland forest with riparian subalpine vegetation along the streambanks and floodplains. Vegetation loss and ecological services losses (89.2%) were very high in the riparian area, while extensive injury to the hillslope spruce and fir forest also occurred (Peacock 2007). The natural stream channel of Lulu Creek was severely altered during the breach event and resulted in 100% loss of channel ecological services (Peacock 2007). Conditions immediately after the breach consisted of only a few reaches of a defined stream channel and no remnants of riparian vegetation. Areas of steep and highly erodible banks persist with conditions that are too unstable or unsuitable to support natural revegetation. Zone 2 had a loss of ecological services over nearly 9 acres, as 6 acres of riparian vegetation have been destroyed and understory vegetation has been damaged in the buffer zone along the creek (Cordova 2006; Peacock 2007).

Following the breach, it was estimated that approximately 23,500 cubic yards of sediment were deposited in Zone 2, including over 13,500 cubic yards along the main stream channel. Nearly 10,000 cubic yards were deposited in the alluvial fan that formed where Lulu Creek meets the Colorado River (Cooper 2007a). A summary of the initial estimate of sediment deposited within each zone is provided in table 1.1. Due to high flow and sediment deposition on high surfaces, many areas within zone 2 are now above the existing stream channel and disconnected from the water table. For further discussion of impacts on zone 2, please reference appropriate sections of chapter 3, "Affected Environment."

Table 1.1: Sediment Distribution by Zone

Zone	Deposited (cubic yards)[a]
Zone 2	23,515
Main channel	13,785
Alluvial fan	9,730
Zone 3	13,785
Zone 4 (2007 estimate / 2009 estimate)	10,343/14,000[b]
Total Volume Eroded	47,643

a. Estimated amount of sediment and debris deposited following the breach, based on a summary by Cooper 2007.
b. Amount based on data collected in 2009.

Zone 3. Zone 3 suffered a 100% loss of subalpine fir and 16% loss of Engelmann spruce trees within the area. A little over half of the shrub and herbaceous plants in the injured area were lost. These vegetation injuries resulted in an estimated 48% and 50% loss of riparian and channel ecological services, respectively (Peacock 2007). Nearly 14,000 cubic yards of sediment from zones 1 and 2 were deposited in this zone and continue to affect hydrologic conditions. For further discussion of impacts on zone 3, please reference appropriate sections of chapter 3, "Affected Environment."

Zone 4. Aerial photographs taken in 2001 allow a baseline comparison to photographs taken in the summer of 2003 after the breach. Immediately following the breach, researchers estimated that over 10,000 cubic yards of sediment were deposited in zone 4, with depositions ranging from less than an inch to more than 3 feet thick. These changes produced an estimated 95% loss of ecological services in zone 4 in 2003 (Peacock 2007). Since then, research conducted in 2009 in the wetland estimated the amount of sediment deposited as a result of the breach, including sediment that has been transported into the zone since 2003. Based on this research, the volume of sediment within zone 4 is estimated to be approximately 14,000 cubic yards (Potter 2010a). Note that this estimate of the volume of sediment deposited by the 2003 breach in the wetland is used throughout the remainder of the document. Thick sediment deposits occur where the Colorado River enters the wetland and along the western wetland edge, where portions of the Colorado River have been confined for the past several decades by previous debris flows.

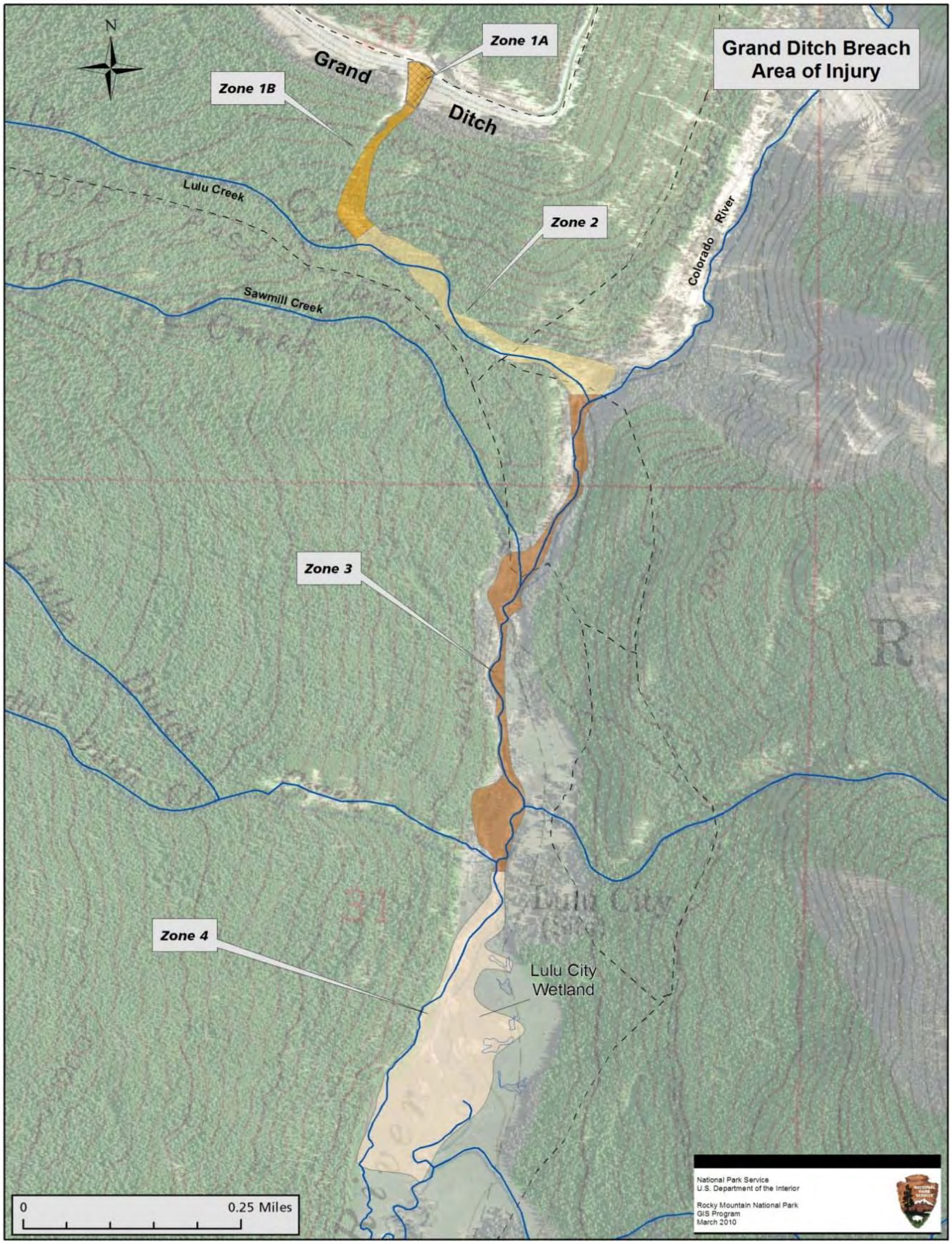


Figure 1.5: Zone designations within the area of injury addressed by this restoration plan

As a result, water discharges from the western channel along the margin of the fan as sheetflow that moves in a southeasterly direction through the wetland. At the time of the damage assessment, no continuous perennial stream channel existed. Vegetation in the wetland was buried and killed. The sediment has raised the ground surface relative to the summer water table, and many areas that were previously wetlands no longer function as such. Other areas now experience high groundwater levels throughout the growing season. Most other areas in the wetland were injured directly by sediment deposition (Cooper 2007b). For further discussion of impacts on zone 4, please reference appropriate sections of chapter 3, "Affected Environment."

Previous Debris Flows

Naturally occurring debris flows occurred within the valley at an infrequent rate, on the scale of geologic time (Braddock and Cole 1990). As a result, the persistence of these deposits along the Colorado River and its tributaries is related to the time between successive debris flows. Based on the geologic mapping in the park, the frequency of debris flow deposits resulting from human actions is greater than those occurring naturally. Thus, the persistence of sediment along the Colorado River and its tributaries is greater than would occur naturally, given the shorter time between debris flows (Rathburn 2007). Recent survey data in the Lulu City wetland show that the wetland had been aggrading before the 2003 breach and that aggradation rates have increased in the last two centuries due to anthropogenic influences (Rubin 2010).

Previous debris flows can be easily distinguished in aerial photos. Figure 1.6 depicts the 2003 breach near Lulu Creek (yellow arrow), and unnamed debris flow near Lady Creek (red arrow) that occurred earlier in the 20th century, and an unnamed debris flow near Dutch Creek (blue arrow) believed to have occurred sometime in the 1950s (Cooper 2007b). The upper portions of Lulu City can be seen at the bottom center. Braddock and Cole (1990) mapped numerous landslide deposits and talus in Rocky Mountain National Park, which included some naturally occurring debris flows and earth flows along the hillslopes of the Colorado River. One deposit of mud, sand, and gravel just north of Baker Gulch and south of the Lulu City wetland was identified as resulting from a debris flow on June 16, 1978, that initiated at an altitude of 10,200 feet. A conclusive study has not been performed, but investigators suspect that the cause of this debris flow may be linked to changes in water flow in the Grand Ditch (Cole and Braddock 2009). Subsequent surface flow along the debris flow track generated deep gullies within the removed sediment. An additional debris flow with similar debris and characteristics was identified as occurring between 1969 and 1974 in Baker Gulch (Braddock and Cole 1990). Based on the geologic mapping in the park, the frequency of debris flow deposits resulting from human actions is greater than those occurring naturally. From examination of aerial photographs from the 20th century, Cooper (2007b) estimates that outside the 7.2-acre area in the Lulu City wetland impacted by the 2003 breach, about 1 to 2 feet of sediment were deposited over large areas of the wetland from previous debris flows. These deposits occurred farther south and east in the wetland. The total amount of sediment within the Lulu City wetland from the 2003 breach and previous debris flows was estimated to be approximately 82,000 cubic yards (Potter 2010a). The impacts resulting from previous debris flows combined with the effects of the 2003 breach are particularly prominent in the Lulu City wetland (as evidenced in a comparison of historical aerial photos of the area in figure 1.7 and in chapter 3, "Affected Environment").

Figure 1.6: 2003 breach (yellow) and previous debris flow locations (blue, red) along the Grand Ditch

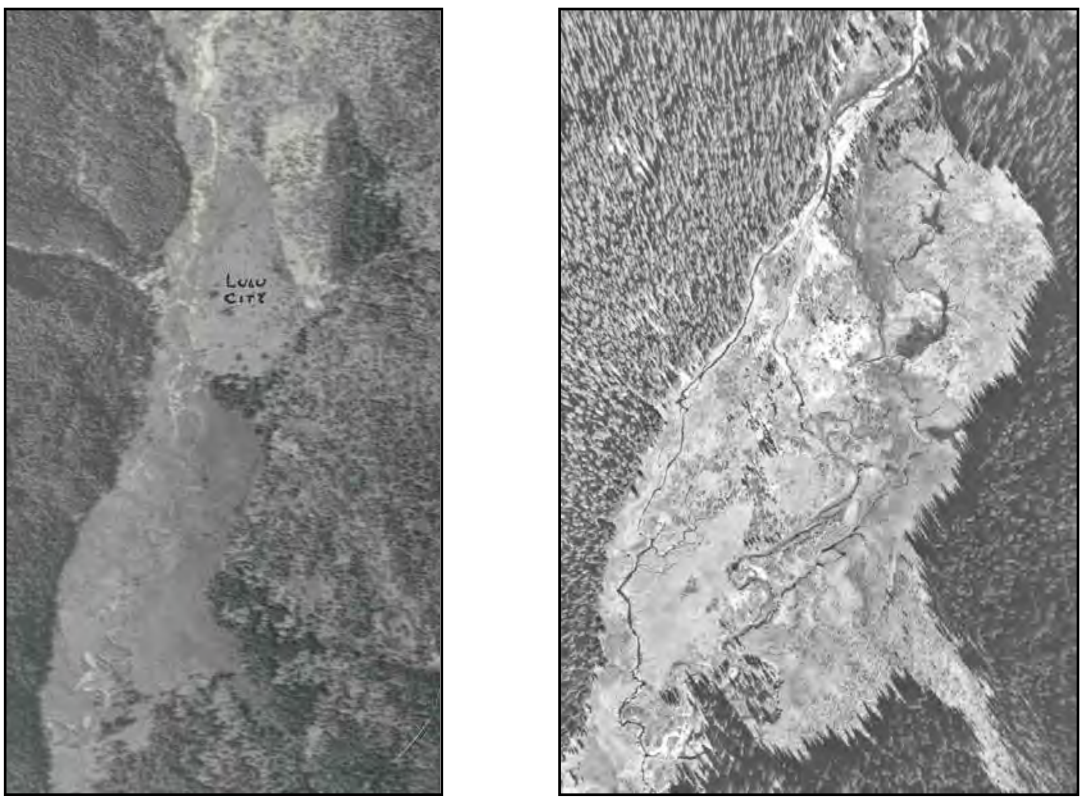


Figure 1.7: Comparison of the 1937 aerial photograph of the Lulu City wetland (left) depicting the historical single braided river channel in the center of the wetland and the 2003 aerial photograph of the Lulu City wetland (right) depicting the river channel on the western edge of the wetland and associated alluvial fan

COOPERATING AGENCIES

Development of this environmental impact statement involved the cooperation of the National Park Service and Grand County. Given the concerns regarding water quality downstream of the impacted area, Grand County asked to become a cooperating agency on the restoration environmental impact statement. The National Park Service is the lead agency and is responsible for all aspects of developing the environmental impact statement, including selecting a preferred alternative and preparing a record of decision. Grand County is the cooperating agency and participates in all aspects of developing the environmental impact statement, including participation in planning meetings, reviewing documents, and providing technical support.

The National Park Service and Grand County have signed a memorandum of understanding to establish how the environmental impact statement would be prepared. The memorandum, which is included in appendix A, delineates the roles and responsibilities of each agency.

PURPOSE OF AND NEED FOR ACTION

This section explains what the restoration project would accomplish and why action is necessary at this time. The purpose and need summarizes the more detailed information provided in the "Project Background" section earlier in this chapter.

The purpose of this project is to restore the natural hydrological processes, ecological services, and wilderness character of the area in the Upper Kawuneeche Valley impacted by the 2003 Grand Ditch breach. Implicit in this purpose is that the ecosystems restored are naturally dynamic and self-sustaining. The goal is to restore the general structure, function, and dynamic but self-sustaining behavior of the systems. The project area includes portions of Lulu Creek, the Colorado River, and the Lulu City wetland.

Restoration is defined as "correcting resource interactions that function unnaturally and ensuring that the directions of the recovery processes are along the upper trajectory, rather than attempting to recreate the endstate of an unimpaired natural system." (NPS 2011)

The National Park Service is obligated by law and policy to maintain and restore, to the extent possible, the natural conditions and processes in park units (NPS 2006a, section 4.1.5). The Upper Kawuneeche Valley area of impact contains more sediment, debris, and subsequent damages from the 2003 Grand Ditch breach than it would under natural conditions. The breach has resulted in highly unnatural conditions within the project area as a large amount of excess sediment has been deposited into the system that remains in an unstable, erodible state. The large volume of sediment resulting from the breach has damaged or eliminated riparian areas, particularly along Lulu Creek, and has highly altered the hydrology and plant community within the Lulu City wetland.

While debris flows within the Kawuneeche Valley have been a natural occurrence before the 2003 breach, the frequency of debris flow deposits resulting from human actions is greater than those occurring naturally. The estimated 47,600 cubic yard debris flow from the 2003 breach resulted in channel morphologic changes, deposition of a large debris fan, increased sedimentation along the Colorado River, sediment deposition in the Lulu City wetland, altered aesthetics of a wilderness area, and tree mortality and scarring. These impacts have degraded the aquatic, riparian, and upland ecosystems, in addition to the wetland communities that support a unique array of species in comparison to other habitat types in the park.

NPS *Management Policies* direct managers to strive to maintain the components and processes of naturally evolving park ecosystems (NPS 2006a). These policies also recognize that if biological or physical processes were altered by human activities, they may need to be actively managed to restore them to a natural condition or to maintain the closest possible approximation of the natural condition. The 2008 settlement between the United States and the Water Supply and Storage Company provides an opportunity for the National Park Service to take action to restore the area impacted by the 2003 event.

OBJECTIVES

Objectives are specific statements of purpose; they describe what must be accomplished, to a large degree, for the project to be considered a success. The following objectives for restoring the area impacted by the 2003 Grand Ditch breach were developed by the planning team and will be used as a measure of performance of the alternatives in the environmental impact statement.

- Restore appropriate stream hydrological and groundwater processes
- Restore appropriate native plant communities
- Restore the stability of the hillside below the breach site
- Restore wilderness character
- Restore wildlife habitat
- Restore aquatic habitat
- Restore water quality in the affected area and downstream

Based on these objectives, the National Park Service has developed specific ecological reference conditions for the area impacted by the Grand Ditch breach, which are presented in chapter 2, “The Alternatives.”

PARK PURPOSE AND SIGNIFICANCE

National park system units are established by Congress to fulfill specific purposes, based on the unit’s unique and significant resources. A unit’s purpose, as established by Congress, is the foundation on which later management decisions are based to conserve resources while providing “for the enjoyment of future generations.”

The purpose and significance of Rocky Mountain National Park and its broad mission goals are derived from its enabling legislation and are summarized in the park’s strategic plan (NPS 2005b). The purpose, need, objectives, and range of alternatives presented in this environmental impact statement are grounded in the park’s purpose and mission.

Excerpts relevant to the Grand Ditch breach restoration are provided below.

Establishment

Congress established Rocky Mountain National Park on January 26, 1915. The enabling legislation states (38 Stat. 798)

> Said area is dedicated and set apart as a public park for the benefit and enjoyment of people of the United States…with regulations being primarily aimed at the freest use of the said park for recreation purposes by the public and for the preservation of the natural conditions and scenic beauties thereof…

Significance of Rocky Mountain National Park

As stated in the park's 2005–2008 strategic plan (NPS 2005b), Rocky Mountain National Park is significant because

> Rocky Mountain National Park provides exceptional accessibility to a wild landscape with dramatic scenery, opportunities for solitude and tranquility, wildlife viewing, and a variety of recreational opportunities.
>
> The fragile alpine tundra encompasses one third of the park and is one of the main scenic and scientific features for which the park was established. This is one of the largest examples of alpine tundra ecosystems preserved in the national park system in the lower 48 states.
>
> The park, which straddles the Continental Divide, preserves some of the finest examples of physiographic, biologic, and scenic features of the Southern Rocky Mountains. The park contains the headwaters of several river systems, including the Colorado River. Geologic processes, including glaciation, have resulted in varied and dramatic landscape. Elevations span from 7,630 feet to 14,259 feet atop Longs Peak, a landmark feature.
>
> The park's varied elevations encompass diverse ecosystems where wilderness qualities dominate. Varied plant and animal communities and a variety of ecological processes prevail.

In October 1976, Rocky Mountain National Park was recognized as an International Biosphere Reserve. This recognition highlights the significance of the park's natural ecosystems, which represent the Rocky Mountain Biogeographic Province. As an element of the Biosphere Reserve, Rocky Mountain National Park is part of a network of protected samples of the world's major ecosystem types, devoted to conservation of nature and genetic material and to scientific research in service of man.

RELEVANT LAWS, POLICIES, PLANS, AND CONSTRAINTS

Numerous laws, regulations, policies, and planning documents at the federal, state, and local levels guide the decisions and actions that can be taken to restore the site from impacts resulting from the 2003 Grand Ditch breach. This section describes relevant laws, regulations, policies, and plans to show the constraints this environmental impact statement must operate under and the goals and policies that it must meet.

FEDERAL LEGAL FRAMEWORK

National Park Service Legislation and Policy

In the Organic Act of 1916, which established the National Park Service, Congress directed the Department of the Interior and the National Park Service to manage units "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (title 16, *United States Code* [USC], section 1). Congress reiterated this mandate in the Redwood National Park Expansion Act of 1978 by stating that the National Park Service must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically directed by Congress" (title 16, USC, section 1a-1).

Within these mandates, the Organic Act and its amendments afford the National Park Service latitude when making resource decisions that balance visitor recreation and resource preservation. By these acts, Congress "empowered [the National Park Service] with the authority to determine what uses of park resources are proper and what proportion of the park's resources are available for each use" (Bicycle Trails Council of Marin v. Babbitt, 82 F.3d 1445, 1453 [9th Cir. 1996]).

NPS *Management Policies 2006* establishes service-wide policies for the preservation, management, and use of park resources and facilities. These policies provide guidelines and direction for management of resources within the park. The proposed action to restore areas within Rocky Mountain National Park that have been impacted by the 2003 breach is consistent with NPS *Management Policies*. Section 4.1 prohibits intervention in natural biological or physical processes, except

> to restore natural ecosystem functioning that has been disrupted by past or ongoing human activities. . . . Biological or physical processes altered in the past by human activities may need to be actively managed to restore them to a natural condition or to maintain the closest approximation of the natural condition when a truly natural system is no longer attainable. . . . Decisions about the extent and degree of management actions taken to protect or restore park ecosystems or their components will be based on clearly articulated, well-supported management objectives and the best scientific information available (NPS 2006a).

Regarding wetland characteristics or function, NPS *Management Policies 2006* Section 4.6.5 states that "when natural wetland characteristics or functions have been degraded or lost due to previous or ongoing human actions, the Service will, to the extent practicable, restore them to predisturbance conditions" (NPS 2006a). In addition, *Management Policies 2006* (section 1.4) requires analysis of potential effects to determine whether proposed actions would impair a park's resources and values.

The fundamental purpose of the national park system, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values. However, the laws give the National Park Service the management discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of the park. That discretion is limited by the statutory requirement that the National Park Service must leave resources and values unimpaired unless a particular law directly and specifically provides otherwise.

The prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values (NPS 2006a). Whether an impact meets this definition depends on the particular resources that would be affected; the severity, duration, and timing of the impact; the effects of the impact; and the cumulative effects of the impact in question and other impacts.

An impact on any park resource or value may, but does not necessarily, constitute impairment. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is:

- Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park, or
- Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park, or
- Identified in the park's general management plan or other relevant NPS planning documents as being of significance.

An impact would be less likely to constitute impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values and it cannot be further mitigated.

Impairment may result from visitor activities; NPS administrative activities; or activities undertaken by concessioners, contractors, and others operating in the park. Impairment may also result from sources or activities outside the park.

Impairment findings are not necessary for impact topics such as visitor experience, socioeconomics, public health and safety, environmental justice, land use, and park operations because impairment findings relate to park resources and values.

A nonimpairment determination for the NPS' preferred alternative will be appended to the record of decision for this project.

The National Environmental Policy Act of 1969 (PL 91-190, 83 Stat. 852, 42 USC §4341 et seq.) established a process to help public officials make decisions based on an understanding of environmental consequences and take actions that protect, restore, and enhance the environment. Regulations implementing the act are set forth by the Council on Environmental Quality. Additional regulations are provided by the National Park Service, including Director's Order #12, which ensures that documents meet Department of the Interior and NPS standards. The National Park Service is the lead National Environmental Policy Act agency.

NPS *Director's Order #12 (Conservation Planning, Environmental Impact Analysis, and Decision-Making) and Handbook* (NPS 2001c) lay the groundwork for how the National Park Service complies with the National Environmental Policy Act. They set forth a planning process for incorporating scientific and technical information and establishing a solid administrative record for NPS projects. Director's Order #12 requires that impacts on park resources be analyzed in terms of their context, duration, and intensity. It is crucial for the public and decision-makers to understand implications of the project impacts in the short term, long term, and cumulatively, as well as the site's context, based on an understanding and interpretation by resource professionals and specialists.

The Park System Resource Protection Act (16 USC § 19jj) allows the National Park Service to both seek and retain response costs and damages for injuries to park resources. The act states in Section 19jj-2:

> The Attorney General, upon request of the Secretary after a finding by the Secretary – 1) of damage to a park system resource; or 2) that absent the undertaking of response costs, damage to a park system resource would have occurred – may commence a civil action in the United States district court for the appropriate district against any person who may be liable under Section 19jj-1 of this title for response costs and damages.

The act also states in Section 19jj-3:

> Response costs and damages recovered by the Secretary under the provisions of this subchapter or amounts recovered by the Federal Government under any Federal, State, or local law or regulation or otherwise as a result of damage to any living or nonliving resource located within a unit of the National Park System, except for damage to resources owned by a non-Federal entity, shall be available to the Secretary and without further congressional action may be used only as follows:
>
> **(a) Response costs and damage assessments**
>
> To reimburse response costs and damage assessments by the Secretary or other Federal agencies as the Secretary deems appropriate.
>
> **(b) Restoration and replacement**
>
> To restore, replace, or acquire the equivalent of resources which were the subject of the action and to monitor and study such resources: Provided, That no such funds may be used to acquire any lands or waters or interests therein or rights thereto unless such acquisition is specifically approved in advance in appropriations Acts and any such acquisition shall be subject to any limitations contained in the organic legislation for such park unit.

Section 19jj addresses the restoration of services with its definition of "damages":

> "Damages" includes compensation for… (ii) the value of any significant loss of use of a park system resource pending its restoration or replacement or the acquisition of an equivalent resource.

NPS ***Director's Order #14 (Resource Damage Assessment and Restoration) and Handbook*** guides restoration actions with its statements:

> **6.7 – Defining Restoration Needs**: In all cases, the NPS will consider primary restoration on-site and in-kind, whenever, and wherever feasible to do so. The NPS will also implement, where appropriate, restoration of all lost services associated with injured park system resources, with an emphasis on restoring comparable resource services as further defined in the Handbook.
>
> **6.9 – Restoring Resources**: Once recovery of damages is made, the NPS will implement feasible and effective restoration of all injured park system resources in a timely manner.

Other Relevant Federal Laws and Policies

A variety of federal laws and policies guide the environmental compliance process. These regulations have been designed to ensure that the public and appropriate regulatory agencies are aware of proposed major federal actions and impacts on the human and natural environment that would result from implementing those actions.

A listing of the primary examples of legal and regulatory constraints and bounds follow. Details of these mandates can be found in the "Affected Environment" and "Environmental Consequences" sections of the relevant impact topics.

- The Endangered Species Act of 1973 established protection over and conservation of threatened and endangered species and the ecosystems upon which they depend. The act requires federal agencies to conserve listed species and consult with the U.S. Fish and Wildlife Service when proposed actions may affect listed species or critical habitat (see "Special Status Species"). In support of the proposed action, a separate biological assessment has been prepared and submitted to the U.S. Fish and Wildlife Service for consultation purposes (appendix B).

- The Wilderness Act of 1964 states that wilderness must be managed in a manner that leaves it unimpaired for future use and enjoyment as wilderness. On March 30, 2009, under the Omnibus Public Lands Management Act of 2009, the Rocky Mountain National Park Wilderness Area, encompassing nearly 250,000 acres, including the proposed project area, became permanently protected from human impacts. All actions affecting the parks' designated wilderness must comply with this legislation (see "Wilderness").
- The National Historic Preservation Act of 1966 (Section 106) requires federal agencies to consider the effects of their undertakings on properties listed or potentially eligible for listing on the National Register of Historic Places. All actions affecting the parks' cultural resources must comply with this legislation (see "Cultural Resources").
- Under the Clean Water Act, Section 404, the U.S. Army Corps of Engineers is authorized to regulate the alteration of stream channels under Section 404 of the act. According to Sections 303 and 402 of the Act, the State of Colorado and the Environmental Protection Agency are responsible for regulating and enforcing water quality standards and authorizing the discharge of pollutants under the National Pollutant Discharge Elimination Program. The U.S. Army Corps of Engineers will be consulted regarding the restoration of stream channels and wetlands within the project area, and the National Park Service will obtain all necessary permits for the project from the U.S. Army Corps of Engineers.

PLANNING DOCUMENTS FOR ROCKY MOUNTAIN NATIONAL PARK

Rocky Mountain National Park Master Plan, 1976

The most recent master plan for this park was written in 1976 and, for the current analysis, serves as the park's general management plan. The master plan established guidelines for the overall use, preservation, management, and development of the park. It identified the purposes for the various areas of the park, its relationship to regional environs, its resource values, and which human-environment needs should be met, and it set forth park management objectives. This document established three management zones in the park, including the scenic viewing or drive-through zone, the day-use zone, and the primitive or backcountry zone, and it established resource management and development standards for each. It also contains a land classification plan and a general development plan.

The 1976 plan included the following management objective, relevant to the goals of the Grand Ditch breach restoration:

> To provide management for the soil, water, flora, and fauna, native to this portion of the Rocky Mountains, so as to minimize the impact of man, and where desirable and feasible restore those ecosystems altered by man. Restoration will be aimed at presenting as close an approximation of primitive conditions as possible.
>
> If dynamic ecosystems are to be perpetuated, natural forces must prevail. The basic strategy is clear: restore missing plant, animal and fish types, and ensure that natural environmental rhythms continue.

Rocky Mountain National Park Vegetation Restoration Management Plan, 2006

The vegetation restoration management plan provides the guidelines, procedures, and techniques to be applied in vegetation and ecological restoration activities in the park, including classifying areas and determining an approach to treatment. The goals of the plan include using local genotypic plants for restoration efforts, stabilizing disturbed sites before they deteriorate further, and controlling the establishment and perpetuation of nonnative species. It states that each restoration effort should include preserving the genetic integrity of native plants, collecting baseline data, and carrying out a quantitative monitoring program throughout the life of the project.

The Grand Ditch breach restoration project will be consistent with the park's vegetation restoration management plan. Both will work toward preserving the genetic integrity of native plants, reducing invasive plant species, collecting consistent monitoring data, and restoring native communities within the park.

Backcountry Wilderness Management Plan, 2001 (currently under revision)

This plan addresses the wilderness areas in Rocky Mountain National Park. It formalizes the management guidelines for undeveloped areas of the park that are defined as backcountry. The plan provides direction for management of natural and cultural resources within the context of wilderness management policies. It also identifies the park's long-range management goals and objectives for backcountry wilderness areas and sets forth actions to meet those objectives. The plan formalizes management practices in the park for the protection of wilderness values and resources, including the requirement that a minimum tool analysis be conducted for management actions that take place in wilderness areas. Activities conducted as part of the Grand Ditch breach restoration project will be consistent with the guidelines set forth in the backcountry wilderness management plan.

Elk and Vegetation Management Plan, 2007

This plan analyzes a range of alternatives and management actions for elk and vegetation within Rocky Mountain National Park. The analysis includes the elk population that primarily winters in the eastern part of the park and in the Estes Valley and primarily summers in the Kawuneeche Valley and alpine areas of the park; it also considers the vegetation resources on the elk's primary winter and summer ranges inside the park. Among other actions to manage the elk herd and restore vegetation, fences will be installed to protect aspen and montane riparian willow on the primary elk range. The National Park Service will determine the need for fences based on monitoring the response of vegetation to reduced elk numbers, lethal reduction activities, and redistribution methods. The reduction in the size and concentration of the elk population would enhance the sustainability of restored willow in the project area. Actions proposed as part of the Grand Ditch breach restoration project, such as fences to protect vegetation, could require coordination with the *Elk and Vegetation Management Plan*.

Bark Beetle Management Plan, 2005

Bark beetles have killed millions of acres of evergreen trees (primarily lodgepole pine) in the western United States and Canada. They have killed thousands of acres of lodgepole pine trees in Rocky Mountain National Park, including trees in the vicinity of the Grand Ditch breach. The *Bark Beetle Management Plan* describes integrated pest management strategies, including the use of insecticides, to protect high-value trees in some frontcountry areas of the park. The proposed project is consistent with the goals of the bark beetle management plan to promote forest health through the restoration of upland species. Those upland areas restored in the project area would be protected as needed through the management techniques identified in the *Bark Beetle Management Plan*.

Rocky Mountain National Park Fire Management Plan, 2012

This plan is a detailed plan of action for all wildland fire activities, including preparedness, suppression, wildland fire use, fire prevention, fire monitoring, and fuels management activities. Included are the monitoring and evaluation processes, goals of the fire management program, and descriptions of the fire regimes, condition class, and ecosystem processes of the major vegetative associations found within each fire management unit at Rocky Mountain National Park.

The goals in the plan include such concepts as protecting life and property, using a variety of fire management tools, allowing wildland fire to achieve its natural role in the ecosystem, and avoiding unacceptable effects. Each of the eleven fire management units has unique natural attributes and has different objectives established by this plan. The objectives of the Grand Ditch breach restoration are consistent with those of the fire management plan in promoting healthy, sustainable forests. The Grand Ditch breach restoration activities would not interfere with the management strategies of use of sustainable fire within the Cache La Poudre Fire Management Unit.

Invasive Exotic Plant Management Plan, 2003 (currently under revision)

Over 100 species of exotic herbaceous plants and grasses occur in Rocky Mountain National Park. Of these, 35 species have been identified as a threat to the park's natural resources and targeted for control. Since the 2003 Grand Ditch breach, exotic species have been noted in the disturbed area. The restoration of disturbed area under the proposed action would prevent or greatly reduce the opportunity for expansion of invasive exotic plant species in this portion of the park. Management of invasive exotic plants before, during, and after the Grand Ditch breach restoration will follow the protocols included in the *Invasive Exotic Plant Management Plan*.

SCOPING PROCESS AND PUBLIC PARTICIPATION

SCOPING ACTIVITIES

Scoping is the effort to involve agencies and the general public in determining the issues to be addressed in the environmental evaluation. Among other tasks, scoping determines important issues and eliminates unimportant issues; allocates assignments among the interdisciplinary team members; identifies related projects and associated documents; and identifies other permits, surveys, or consultations required by other agencies.

The Council on Environmental Quality regulations for implementing National Environmental Policy Act (1978) and the NPS National Environmental Policy Act guidelines contained in NPS *Director's Order # 12: Conservation Planning, Environmental Impact Analysis and Decision Making Handbook* (NPS 2001c) require public scoping of federal actions that would require an environmental impact statement. The National Park Service conducted scoping for the proposed Grand Ditch breach restoration project to ensure input from all interested stakeholders.

On March 18, 2010, a notice of intent to prepare an environmental impact statement was published in the *Federal Register* (Federal Register, Volume 75, Number 52).

In May 2010, a newsletter distributed to the park's mailing list of individuals, Native American Tribes, organizations, and businesses summarized the purpose of and need for the project, identified potential issues, and presented opportunities for public involvement in the National Environmental Policy Act process.

Two public meetings were held to gather comments and record issues related to the proposed restoration project – one in Grand Lake and one in Fort Collins. These meetings were preceded by website announcements and distribution of the project newsletter. Each public meeting included a presentation on the project, and NPS staff members were available to discuss the project, answer questions, and record comments.

The National Park Service received 112 written and oral comments from 12 individuals and/or organizations on the restoration options, the environmental planning process, and other concerns about the project. In response to public and agency comment, the interdisciplinary planning team refined the issues and developed restoration alternatives that this environmental impact statement addresses.

Draft alternatives were presented to the public in the fall 2010 newsletter. During this phase of scoping, the public was asked to provide input on the preliminary draft alternatives and to suggest additional restoration approaches. The National Park Service held two public meetings on the draft alternatives on October 12 and 14 in the locations listed above, with a total of 18 people in attendance. From the 25 people who submitted comments through letters, email, online, and during public meetings, approximately 100 comments specifically relating to this project were identified. A report summarizing the comments on the preliminary draft alternatives was made available to the public on the National Park Service park planning, environment, and public comment website.

The draft environmental impact statement was released for public review on March 16, 2012 for a 60-day comment period. Respondents were encouraged to comment electronically on the NPS Planning, Environment, and Public Comment (PEPC) website; by letter; or in person at public meetings. The comment period closed on May 25, 2012.

The National Park Service held public meetings on the draft environmental impact statement on April 11 and 12, 2012. The public meetings were held to provide background information on the Grand Ditch breach and its impacts, to inform the public of the availability of the draft environmental impact statement, and to provide an opportunity to receive input from the public. A total of seven members of the public attended the scoping meetings, three in Fort Collins and four in Grand Lake.

The NPS received a total of 10 response documents in addition to oral comments received at the public meetings. The documents submitted contained multiple individual comments or suggestions regarding the Grand Ditch breach restoration project.

Comments received during review of the environmental impact statement were determined to be “substantive” or “non-substantive” under the definition articulated in Directors Order 12 (DO-12, section 4.6). Substantive comments under DO-12 are defined as those that do one or more of the following:

- Question, with reasonable basis, the accuracy of information in the environmental impact statement;
- Question, with reasonable basis, the adequacy of environmental analysis;
- Present reasonable alternatives other than those presented in the environmental impact statement; or
- Cause changes or revisions in the proposal.

Comments meeting these definitions were responded to and, where appropriate, text changes were made to the draft environmental impact statement. Any comments not meeting these definitions (e.g., comments on the Claim Report, the settlement, or the Park System Resource Protection Act) were considered non-substantive and were not responded to. Based on the review of all public input, a total of 47 substantive comments were received on the draft environmental impact statement. NPS responses to substantive comments are included in appendix C. A summary of the agency and public scoping activities is presented in chapter 5, "Consultation and Coordination."

AGENCY AND TRIBAL CONSULTATION

Scoping also includes early input from any interested Native American Tribes, agency or any agency with jurisdiction by law or expertise. As outlined under "Relevant Laws, Regulations, and Policies" above, the National Park Service is consulting with Native American Tribes and federal agencies, including the U.S. Fish and Wildlife Service, U.S. Forest Service, U.S. Army Corps of Engineers, and the State Historic Preservation Office. NPS consultation and coordination letters and agency responses are included as appendix D.

ISSUES AND IMPACT TOPICS

ISSUES

According to the guidance provided in Director's Order #12, an "issue" under the National Environmental Policy Act describes the relationship between actions (proposed, connected, cumulative, similar) and environmental resources, including natural, cultural, and socioeconomic resources (NPS 2001c). Issues are usually problems that the current management practices have caused or that any of the proposed alternatives might cause. They also may be questions, concerns, or other relationships, including beneficial ones.

Issues need to be addressed in the analysis of the proposed management actions and alternatives. The following issues were identified by the environmental impact statement interdisciplinary team and by the public during the public scoping period. In addition, research and analysis raised further problems, questions, or concerns related to some of these issues. Relevant aspects of those issues that were retained are discussed in detail under the appropriate impact topics in chapter 3, "Affected Environment" and chapter 4, "Environmental Consequences." See chapter 5, "Consultation and Coordination" for a description of public and agency involvement that took place during the development of this environmental impact statement.

Effects on Wilderness Character

Because the area of impact is within designated wilderness in the Upper Kawuneeche Valley, the breach has degraded the wilderness values and character of the area. Activities to restore the impacted area could also affect wilderness character and values. Possible actions such as the transport of debris, revegetation, installation of temporary fences, and the use of helicopters and construction equipment could temporarily degrade the wilderness character within the restoration area.

Effects on Soundscapes

Natural soundscapes within the park could be disturbed by restoration activities requiring a variety of tools that could create short-term sound levels not typically encountered in the wilderness of the Upper Kawuneeche Valley.

Effects on Geological Resources and Hazards

Restoration and stabilizing activities could involve slope stabilization and may affect geological resources by altering the terrain.

Effects on Surface and Groundwater Hydrology

The breach has altered the area's surface hydrology and surface/groundwater interaction from natural conditions. In areas along Lulu Creek and the Colorado River, the sediment has resulted in the stream channel becoming disconnected from the groundwater table, and as a result, perennial surface water flow may be lost. In the Lulu City wetland, deposited debris has resulted in increased sheetflow through the wetland and a loss of continuous perennial flow in the stream channel. The sediment has also raised the ground surface and resulted in the water table being deeper relative to the soil surface, in some areas, than before the sediment deposition. Restoration of the Lulu Creek and Colorado River stream channels could restore and affect hydrological processes in those areas as well as areas downstream.

Effects on Stream Channel, Floodplain, and Wetland Morphology

The breach has altered the stream channel and floodplain of Lulu Creek and the Colorado River from their natural conditions. Sediment deposition and alterations in hydrological condition has affected structure and function (e.g., water quality) of the Lulu City wetland. Restoration could involve restoring the stream channel, redistributing sediment that has built up in the Lulu City wetland, and removing excess downed timber from the stream channels; these activities would affect the floodplain and wetland morphology in the area.

Effects on Water Quality

The breach has resulted in periods of increased turbidity during precipitation due to hillside and streambank erosion. Restoration activities to control erosion and to revegetate could also result in short-term increased soil erosion. Alternatives that stabilize slopes, alter vegetative cover and hydrology, and restore plant communities could improve soils and reduce erosion.

Effects on Upland, Riparian, and Wetland Plant Communities

Upland, riparian, and wetland communities have been altered by debris flow, by sediment erosion and deposition, and by changes in hydrologic conditions in the area. A large amount of upland vegetation along Lulu Creek has been lost due to the breach and continues to be susceptible to loss due to highly erosive bank conditions. Sediment deposited along Lulu Creek and the Colorado River has altered the surface water / groundwater interaction in some areas. This has resulted in a nearly complete loss of riparian vegetation along Lulu Creek and in localized areas along the Colorado River due to drier site conditions. The breach resulted in nearly 8 acres of wetland vegetation being buried and killed in the Lulu City wetland. The sheetflow now present in the wetland may also result in increased distribution of sedges that tolerate wetter conditions. Recontouring steep slopes to reflect more natural conditions could provide conditions suitable for the recovery of upland vegetation. Removal of sediment and debris deposits to restore hydrologic conditions could allow restoration of riparian and wetland plant communities.

Effects on Aquatic Habitat

Aquatic habitats in the project area have been altered by changes in surface and groundwater flows and by movement of sediment, which has subsequently altered riparian and wetland vegetative communities. Restoration of the impacted area could affect the aquatic habitat in Lulu Creek, the Colorado River, and the Lulu City wetland.

Effects on Wildlife and Wildlife Habitat

The breach has resulted in the loss of upland forests and alterations in riparian and wetland communities that provide important habitat for wildlife. Restoration of the areas impacted by the breach, including stream channels, wetlands, and upland terrestrial areas, could affect wildlife and wildlife habitat by restoring the area to pre-disturbance conditions. Restoration activities that produce noise and increase human presence in the area could temporarily displace or disturb wildlife.

Effects on Archaeological and Historical Sites

The Upper Kawuneeche Valley contains numerous cultural resources, and elements of restoration activities involving earth movement could impact archaeological resources and/or historical sites.

Effects on Visitor Experience

Because some people visit the park to experience wilderness character, the proposed restoration activities can impact the wilderness experience for visitors. During restoration, portions of the Colorado River Trail and adjacent trails may be closed to visitors. Temporary fences may be visible, and noise from heavy machinery may be evident. This can detract from the values typically associated with the national park experience, such as solitude and quiet. In addition, restoration could impact visitor experience through aesthetic improvements of the affected landscape.

IMPACT TOPICS

Discussions during scoping examined the range of potential natural and cultural resources and elements of the human environment that might be of concern or might be affected by the implementation of a restoration plan. This review led to the selection of impact topics to analyze in the environmental impact statement. The impact topics examined, along with rationales for their retention or dismissal, are discusses in the following paragraphs. Relevant laws, regulations, and policies specific to given impact topics retained are described in chapter 4, "Environmental Consequences." Those relevant to all topics were discussed in "Relevant Laws, Polices, Plans and Constraints" earlier in this chapter.

The impact topics retained for detailed analysis follow:

Wilderness character: Retained because of the potential for restoration actions to affect designated wilderness in the park.

Natural soundscape: Retained because it could be affected by installation and execution of several of the potential restoration activities. These include, but are not limited to, construction equipment and the use of vehicles and aircraft.

Geology and soils: Retained because of the impacts that the 2003 breach had and continues to have on geology and soils in the Upper Kawuneeche Valley.

Water resources: Retained because of the relationships among vegetation, water resources, wetlands, and debris flows from the 2003 breach. This topic also addresses wetland issues associated with hydrology.

Wetlands: Retained because much of the area of impact in the Upper Kawuneeche Valley consists of wetlands and floodplains. Because the proposed action is to restore wetland and floodplain areas damaged by the 2003 breach, a wetland or floodplain statement of finding has not been prepared for this project. According to Director's Order #77-1, Section 4.2.1.h, a wetland statement of findings is not required for "actions designed to restore degraded (or completely lost) wetland, stream, riparian, or other aquatic habitats or ecological processes." In addition, the proposed action does not involve the development in the floodplain or channel modifications that could adversely affect the natural resources and functions of floodplains or increase flood risks. On the contrary, the proposed restoration actions would enhance and improve floodplain functions. Therefore, a floodplains statement of findings is not required (Director's Order #77-2). For further information on these policies, please see the Wetlands and Water Resources sections of the "Environmental Consequences" chapter.

Vegetation: Retained as one of the primary resources to be restored by this project. This impact topic will include analyses of effects on upland, riparian, and wetland vegetation.

Special status species: Retained because actions taken by the project could have effects on several listed species and on compliance with the Endangered Species Act.

Wildlife: Retained because of the potential of the project to affect other terrestrial and aquatic species of wildlife and their habitats.

Cultural resources: Retained because the breach may have affected historic structures and archeological resources within the project area. Alternatives will need to be evaluated for their potential to affect these resources.

Visitor use and experience: Retained because implementation of restoration activities would impact visitor access and experience within the Upper Kawuneeche Valley. The actions implemented by the project could affect how visitors would experience this area of the park.

Park operations: Retained because the implementation of restoration activities in association with this project would require temporary changes in how this area of the park is operated.

IMPACT TOPICS CONSIDERED BUT NOT EVALUATED FURTHER

The following impact topics were dismissed from further analysis in this document for the reasons noted.

Air quality: Emissions of particulates that could affect air quality, including visibility in the general vicinity of the project area, could temporarily increase during restoration from the potential use of motorized equipment at the site and from exhaust from gasoline- or diesel-powered vehicles and equipment. This equipment would also temporarily emit air pollutants. However, restoration activities requiring the use of heavy machinery would not be expected to be long term. Mitigation measures described in more detail in the "Alternatives" chapter (such as dust suppression) would be employed to minimize or avoid potential effects on air quality. Because of the short-term, localized nature of the operation, restoration activities would not affect the attainment status of the airshed that encompasses Rocky Mountain National Park and would not affect the airshed designation. This impact topic was, therefore, dismissed from further analysis.

Ecologically critical areas or other unique natural resources: The alternatives being considered would not affect any designated ecologically critical areas, wild and scenic rivers, or other unique natural resources, as referenced in the Wild and Scenic Rivers Act, *Management Policies 2006*, 40 *Code of Federal Regulations* [CFR] 1508.27, or the 62 criteria for national natural landmarks.

Indian trust resources: Indian trust assets are owned by American Indians but are held in trust by the United States. Requirements are included in the Secretary of the Interior's Secretarial Order 3206, "American Indian Tribal Rites, Federal–Tribal Trust Responsibilities, and the Endangered Species Act," and Secretarial Order 3175, "Departmental Responsibilities for Indian Trust Resources." No Indian trust assets occur within Rocky Mountain National Park. Therefore, there would be no effects on Indian trust resources resulting from any of the alternatives.

Cultural landscapes: According to the NPS' *Cultural Resource Management* (NPS 1998) guideline, a cultural landscape is

> a reflection of human adaptation and use of natural resources and is often expressed in the way land is organized and divided, patterns of settlement, land use, systems of circulation, and the types of structures that are built. The character of a cultural landscape is defined both by physical materials, such as roads, buildings, walls, and vegetation, and by use reflecting cultural values and traditions.

According to the NPS cultural landscapes inventory database, no cultural landscapes have been identified within the project area. Therefore, cultural landscapes were dismissed from further analysis.

Sacred sites and ethnographic resources: Executive Order No. 13007, "Indian Sacred Sites," requires federal land managers to accommodate access to and ceremonial use of Indian sacred sites by Native Americans and to avoid adversely affecting the physical integrity of such sites. Procedures applicable to lands in national parks are defined in Part 512, chapter 3 of the *Department of the Interior Departmental Manual*.

Management of ethnographic resources is addressed in chapter 10 of *NPS-28: Cultural Resource Management* (NPS 1998). This identifies ethnographic resources as "variations of natural resources and standard cultural resource types. They are subsistence and ceremonial locales and sites, structures, objects, and rural and urban landscapes assigned cultural significance by traditional users."

The Ute and Arapahoe tribes are closely associated with the land within Rocky Mountain National Park, and the park holds many resources important to these tribes. However, no ethnographic resources or sacred sites have been identified within the project area, and therefore these resources have been dismissed from further consideration.

Socioeconomics: Section 1508.8 of the Council on Environmental Quality (1978) guidelines for implementing the National Environmental Policy Act establishes that "effects" include "ecological, aesthetic, historic, cultural, economic, social, or health." However, section 1508.14 clarifies that economic and social effects need to be considered only when they are interrelated with natural or physical environmental components regarding effects on the broader "human environment."

Socioeconomics were eliminated from detailed consideration because the alternatives would involve only minor potential changes in the economic and social conditions of Grand County (or elsewhere) over the life of the project.

During the project implementation period, funds could be spent on staff time, contractors, material, and equipment to perform the restoration activities. Under the NPS preferred alternative, approximately $9 million would be expended, and a maximum of $18 million under the most expensive alternative. Under any of the action alternatives, it is uncertain how much of the total project cost would be spent directly in the Grand County economy for labor, materials, or equipment. Total annual personal income in Grand County in 2009 was approximately $543 million (U. S. Department of Commerce 2012). Maximum annual project expenditures over three years would represent less than 1% of all county personal income and would result in no more than a minor beneficial impact on the county economy.

During restoration activities, some visitors could avoid the area because of perceived reductions in experience or wilderness quality and could choose recreation alternatives outside of Grand County. A small percentage of the park's total visitors travel in the project area. In 2010, a total of 721 overnight stays were recorded in the project area. A somewhat greater, but unknown, number of day hikers likely travel as far as the project area. A loss of these visitors and their expenditures within Grand County would represent, in the worst case, no more than a short-term, minor, adverse impact on the economy of Grand County.

Water quality impacts from the project could impact the Grand County economy if sediment or nutrients released by restoration actions affected water quality and clarity in the Three Lakes and caused declines in tourism or property values, or resulted in increased costs to the county to remediate impacts directly attributable to restoration activities. Water quality impacts are described in chapter 4. Any effects on water quality, however—whether adverse or beneficial—are expected to be such a small fraction of all the factors that affect the socioeconomics of Grand County (e.g., tourism, property values, costs to remediate, etc.), that they would be negligible to minor. Therefore, the socioeconomic impact would be minor, and socioeconomics was dismissed from further analysis.

Museum collections: Museum collections (prehistoric and historic objects, artifacts, works of art, archival material, and natural history specimens) would be unaffected by the implementation of any alternative. The Park's museum collections would continue to be acquired, accessioned/cataloged, preserved, protected, and made available for access and use according to NPS standards and guidelines. Therefore, museum collections are dismissed as an impact topic.

Energy requirements and conservation potential: The National Park Service reduces energy costs, eliminates waste, and conserves energy resources by using energy-efficient and cost-effective technology. Energy efficiency is incorporated into the decision-making process during the design and acquisition of buildings, facilities, and transportation systems that emphasize the use of renewable energy sources. Under any alternative, the National Park Service would continue to implement its policies of reducing costs, eliminating waste, and conserving resources by using energy-efficient and cost-effective technology (NPS 2006a). The proposed action alternatives would not appreciably change the park's short- or long-term energy use or conservation practices. The gasoline and diesel fuel used during restoration activities would not result in detectable changes in energy consumption at a local or regional level; therefore this impact topic has been dismissed.

Environmental justice: Executive Order 12898, "General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. Guidelines for implementing this executive order under the National Environmental Policy Act are provided by the Council on Environmental Quality. According to the U.S. Environmental Protection Agency (1998), environmental justice is

> The fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies. The goal of this "fair treatment" is not to shift risks among populations, but to identify potentially disproportionately high and adverse effects and identify alternatives that may mitigate these impacts.

Residents within the surrounding communities of the park are not disproportionately minority or low-income. Proposed restoration activities in the Upper Kawuneeche Valley would not disproportionately affect low-income or minority populations. Therefore, this topic has been dismissed from further consideration.

Natural or depletable resource requirements and conservation potential: As directed by *Management Policies 2006* (NPS 2006a), the National Park Service strives to minimize the short- and long-term environmental impacts of development and other activities through resource conservation, recycling, waste minimization, and the use of energy-efficient and ecologically responsible materials and techniques. Although energy and construction materials would be used for restoration activities under each of the action alternatives, none of the proposed alternatives would change the park's overall energy consumption, use of nonrenewable (depletable) resources, or conservation potential. Thus, this topic is eliminated from analysis.

Public health and safety: Over the long term, restoration activities proposed under the action alternatives could reduce the potential for unsafe conditions during high runoff. Although no injuries related to the breach or subsequent movement of debris has been recorded, the absence of vegetation and slope erosion results in unstable conditions in the area of impact. Under the proposed action alternatives, revegetation and restoration would produce more stable conditions in the impacted area. This would result in an improved safety environment and long-term, minor benefits to the health and safety of visitors, researchers, and NPS staff. During project implementation, all proposed restoration activities addressed in this environmental impact statement would be conducted by experienced contractors or park staff operating under Occupational Safety and Health Administration guidelines. Park visitors and staff would be restricted from entering any restoration areas, as appropriate, throughout project implementation. Therefore, no effects on public health and safety are anticipated.

Possible conflicts with other land use plans and policies: The proposed project would not interfere with plans or policies of Arapahoe and Roosevelt National Forests and Pawnee National Grassland or other park neighbors. The relationship of this project to other past, present, and reasonably foreseeable actions, within and adjacent to the park, is addressed in the cumulative impact analyses.

Prime and unique farmland: The Council on Environmental Quality 1980 memorandum on prime and unique farmlands states that prime farmlands have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. Unique agricultural land is land other than prime farmland that is used for production of specific high-value food and fiber crops. Both categories require that the land be available for farming uses. Lands within Rocky Mountain National Park are not available for farming and therefore do not meet the definitions.

CHAPTER 2:
ALTERNATIVES

INTRODUCTION

The National Environmental Policy Act requires that federal agencies explore a range of reasonable alternatives and analyze effects that the alternatives could have on the natural and human environment. The "Environmental Consequences" chapter of this Grand Ditch Breach Restoration environmental impact statement presents the results of the analyses. The alternatives under consideration must include a "no action" alternative as prescribed by 40 CFR 1502.14. Alternative A in this EIS is considered the no action alternative because it continues current management of the area impacted by the 2003 Grand Ditch breach, and it assumes that the National Park Service would not implement changes to the current condition. The four action alternatives presented in this chapter were developed by the NPS interdisciplinary planning team using feedback from the public during the public scoping process.

Each of the four action alternatives meets, to varying degrees, the objectives for restoration of the impacted area and also addresses the purpose of and need for action as expressed in the "Purpose of and Need for Action" chapter. Because each action alternative responds to the objectives and is technically and logistically feasible to implement, all are considered "reasonable."

This chapter describes the development process of the alternatives. It also describes each alternative, summarizes the important features of the alternatives, discusses their effectiveness in meeting the restoration objectives, and summarizes the effects of the alternatives on park and regional resources. The chapter also identifies actions or alternatives that have been eliminated from further consideration and discusses the environmentally preferable alternative.

PROJECT BACKGROUND

The National Environmental Policy Act requires that alternatives be evaluated with respect to baseline or existing conditions. The baseline is essentially a description of the affected environment at a fixed point in time.

The purpose of chapter 3, "Affected Environment," is to provide the public with a detailed description of baseline conditions for each resource topic. This project background section has been provided to allow the public to understand the baseline hydrologic and geomorphic conditions that affect the ecological processes within the project area. Baseline conditions provide a context to the proposed changes within each zone under the action alternatives. Note that the baseline condition presented below in this section is based upon investigation generated between 2003 and 2009. Since that time, there have been two high spring runoffs—one in 2010 (a 30-year flow event) and another in 2011 (a 60-year flow event)—that have eroded and deposited additional sediment and debris within the project area and further downstream. Information about how these high-flow events have changed the distribution of the 2003 breach debris and sediment within the project area is not available at this time.

The project area is organized into five impact zones, each generally corresponding with fundamentally different topographic soil, hydrologic, aquatic, and vegetative conditions from the other zones. Potential restoration solutions tend to differ in each of the zones because of these physical and biological differences. Zone identification starts with 1A at the head of the watershed and moves progressively downgradient to zone 4. The following descriptions of conditions within each zone further elaborate on those described in chapter 1 in the section titled "Injury by Zone."

ZONE 1A

Zone 1A includes the heavily incised and eroded scar that resulted from the breach of the Grand Ditch. Approximately 47,600 cubic yards of the hillslopes below the ditch were carved out and eroded downstream as a result of the breach. The following description of the conditions in this zone is based on evaluations by geotechnical engineers (Telesto Solutions, Inc. 2007 and 2008). To allow continued operation of the ditch, emergency repairs were implemented soon after the breach that included construction of a dual-barrel buried culvert through the breach area. Additional repairs were completed in 2009, when a concrete box culvert was installed. Spoils from the uphill slope excavation appear to have been used at the head of the scar as backfill to reestablish the service road though this area. The post-breach bed slope of the hillside is slightly steeper than 1.4 to 1 horizontal to vertical (35 degrees), with lateral edges of the scar locally steeper than 1 to 1 (45 degrees), resulting in edges of the upper scar that overhang. There is concern that the scar in zone 1A may be eroding the slopes and expanding laterally, which could threaten the integrity of the surrounding fill slope, the ditch service road, and nearby sections of the ditch. Tension cracks in the historical fill slopes have developed just outside of and roughly parallel to the lateral edges of the scar, indicating instability in the over-steepened lateral scarps of the scar. The slopes in zone 1A are unlikely to remain stable in the long term and may ultimately erode away (Telesto Solutions, Inc. 2007). The scar area is not vegetated, unlike the pre-breach condition. Before the breach, the affected slope was probably very similar to the adjacent fill slopes: steep and sparsely vegetated.

ZONE 1B

This zone includes an eroded gully created by the breach and the adjacent forested hillside below zone 1A. Before the breach, the slopes of zone 1B were vegetated by lodgepole pine, Engelmann spruce, and subalpine fir forest and did not contain a channel or gully. Approximately 2,100 trees were destroyed within this area as a result of the breach. Without the stabilizing effects provided by vegetation, the hillside in this zone remains highly unstable, consisting of loose and unconsolidated debris and sediment with slopes that are steeper than before the breach. The "uncovering" of groundwater in the bottom third of zone 1B also created a small surface water tributary to Lulu Creek. In the gully above this tributary, raveling and settling of the gully banks and bottom are ongoing. It is estimated that only 50% of the herbaceous cover of the area would recover naturally over 150 to 200 years. Complete recovery of the natural forest to pre-breach conditions would not occur due to the drastic change in slope and the loss of soil in the area, such that only rock remains (Cordova 2006).

ZONE 2

Zone 2 includes Lulu Creek, its banks, and a narrow floodplain starting at the point where the eroded gully from zone 1B joins the historical Lulu Creek channel. Zone 2 continues downgradient to the point where Lulu Creek joins the Colorado River. As a result of the breach, preexisting landforms, hydrologic regime, and vegetation in this zone were impacted. An estimated 9,300 subalpine fir and 2,200 Engelmann spruce were destroyed. Due to the injury to the vegetation, forest recovery would require several hundred years if relying on natural processes (Cooper 2007b).

If left to natural processes, the substantial morphological changes that have occurred to the channel as a result of the debris flow would persist. There was an initial loss of step-pool bedforms immediately after the breach. However, step-pools are currently redeveloping since the event. Step pools dissipate flow energy, especially during floods, and reduce erosional forces. The debris flow of the breach resulted in a two- to ten-fold widening of the creek channel in zone 2. In areas along the creek, unstable banks are present that consist of loose and unconsolidated debris and sediment and are steeper than existed before the breach or compared to reference conditions. Since 2003, the main creek channel has divided; developed multiple, braided channels, some of which subsequently partially refilled; developed a single-thread channel in some locations; and developed significant channel incising. With time, the degree of change in the channel has slowed as a less unstable configuration has been achieved with each year's snowmelt runoff.

Approximately 23,500 cubic yards of eroded soil and fill material from zone 1A were deposited in zone 2, within the main stream channel and especially in an alluvial fan where Lulu Creek meets the Colorado River. It is estimated that nearly 10,000 cubic yards of eroded soil and fill material have been deposited in the alluvial fan. Under current conditions, large volumes of this material, beyond what would be expected under natural conditions, would continue to be introduced into the channel from bank and bar undercutting and from sloughing of deposited debris in the channel. Rathburn (2007), estimated that up to 7-foot-high banks of unconsolidated debris and sediment exist along zone 2 of Lulu Creek, and bank and bar sediment could be mobilized at even the lowest discharges.

In addition, many areas within zone 2 are now above the existing stream channel and disconnected from the water table (Rathburn 2007). As a result, perennial surface water flow may be lost due to the loss of surface interaction with the groundwater table. Along the majority of Lulu Creek, riparian vegetation has been lost, and conditions no longer exist to support riparian vegetation along the stream channel.

ZONE 3

Zone 3 includes the Colorado River, its banks, and the adjacent floodplain from its confluence with Lulu Creek downgradient to the head of the Lulu City wetland. This zone suffered an estimated loss of approximately 7,000 subalpine fir and 1, 900 Engelmann spruce trees. At the time of the breach, approximately 13,800 cubic yards of sediment were deposited in this zone. As a result, the channel shows varying morphology from a single thread, pool-riffle form with pools on the insides of meander bends to a braided and multi-thread form in the area where the channel gradient shallows and sediment deposition from the breach occurred. Deposits of gravel and cobble bars exist along the entire zone as a result of the breach, with abundant log jams formed from trees and logs that were once footbridges. Log jams support and contain large quantities of fine- to coarse-grained material in this area (Rathburn 2007).

Zone 3 also contains debris and sediment deposits that resulted from other ditch breach and natural slope failures that occurred before the 2003 breach. These old deposits modified the river channel, water direction, and physical channel dimensions. The old deposits are in various states of natural forest, wetland, and grassland revegetation.

ZONE 4

The Lulu City wetland is defined as zone 4, which continues from the confluence with the Colorado River and extends downstream to the end of the open wetland. Approximately 14,000 cubic yards of eroded material were deposited in the wetland as a result of the 2003 breach (Potter 2010a), with sediment deposition ranging from less than an inch to more than 3 feet deep. The thickest deposits are in the alluvial fan, where the Colorado River enters the northern portion of the wetland. As a result of the 2003 breach and pre-2003 debris flows, it is estimated that 82,000 cubic yards of sediment has been deposited in the wetland. As a result, the historical Colorado River channel through the approximate center of the wetland has changed several times and no longer has a continuous channel through the middle of the wetland. The river currently flows through a combination of braided and single channels along the western portion of the wetland. Surface water flows across much of the wetland surface during peak runoff but infiltrates into the thick gravel and alluvial deposits near the upper wetland boundary during low-flow periods. Water is discharged around the alluvial fan as sheetflow during periods of high flow and forms intermittent channels during periods of lower flow. This zone also receives water supply from snowmelt and from groundwater influxes from adjacent mountain slopes, producing a complex hydrologic condition. Lodgepole pine trees, willows, and sedges in the wetland were buried, and many were killed. The deposited material has raised the ground surface relative to the summer water table in some locations, and many areas exhibit different degrees of wetland functions than existed before the 2003 breach. Peak Colorado River runoff conditions continue to import bedload and suspended sediments from zones 2 and 3 into zone 4.

ALTERNATIVE DEVELOPMENT

The alternatives were developed based on an understanding of the proposed action's purpose, need, issues, and objectives, as well as public input obtained during the scoping phase of the project. The National Park Service conducted internal workshops to define the range of alternatives based on the objectives of the proposed action.

One of the assumptions in developing alternatives that are based on restoring process and function is that restoration increases sustainability or resiliency of the proposed project by allowing considerable change in future conditions without requiring maintenance or intervention. Natural processes are extremely dynamic and result in change on a variety of time scales such as seasonal, annual, or other long-term time scales. The park has recognized that dictating a static channel configuration would be futile given the level of natural dynamism in the system. Therefore, to restore natural ecosystem functions and processes, unnatural amounts of sediments and debris that continue to be exposed to erosive forces need to be reduced or stabilized so that they will not be transported downstream in excessive quantities that in turn trigger channel instability. While certain restoration actions within alternatives may focus on realigning streams into historical channels as a way of removing impediments to natural process, the National Park Service acknowledges that it is possible, because of the dynamism of natural fluvial processes, that Lulu Creek and the Colorado River could change their configurations in the future. For instance, in the Lulu City wetland, the historical central channel may one day fill in with sediment and cease to function as a channel. The park recognizes that this type of change or geomorphological evolution as a result of natural processes is inherent to the proposed project.

The range of alternatives captures the most divergent, yet reasonable, scenarios that could be implemented within the area impacted by the 2003 Grand Ditch breach. Each alternative emphasizes a different magnitude of restoration area and different techniques to achieve restoration, such as active revegetation, debris and sediment redistribution, or slope or bank stabilization. The alternatives represent a progression in the ability to meet ecological restoration goals over time. Alternative B, for example, involves the least amount of active restoration (relying heavily on passive restoration) of the area and thus would not fully achieve the project restoration goals even over a very long period. In contrast, alternatives C, D, and E, which rely on a variety of active restoration techniques and restoration intensity, achieve to a much higher level the project restoration goals in a relatively shorter time.

As stated in the "Project Background" section, there is concern that the eroded and back-filled scar in zone 1A may expand laterally and could threaten the integrity of the water conveyance channel, ditch maintenance road, and surrounding fill slope. The slopes in this zone are unlikely to remain stable in the long term and may ultimately erode away (Telesto Solutions, Inc. 2007). Therefore, the National Park Service, in accordance with the settlement, would stabilize zone 1A to prevent further damage to the impacted area and to provide sufficient support to prevent future road, ditch, and slope failure.

Several engineered solutions for repairing and stabilizing the eroded slope in zone 1A were considered by the National Park Service and the Water Supply and Storage Company. The National Park Service identified an option to basically stabilize the existing contours, while the Water Supply and Storage Company identified an approach that filled the eroded gully to the original slope surface contours and then stabilized the slope. Because restoration options for zone 1A are engineered solutions, they may not be consistent with the proposed alternative concepts that apply to the other zones in the project area. The restoration activities proposed for zone 1A therefore are presented independently. Each action alternative includes one or two options for stabilizing this portion of the project area.

After defining the range of alternatives, the National Park Service consulted with experts in various disciplines such as civil engineering, hydrology, ecology, and botany to define and revise the range of restoration actions that could be effective in each restoration area.

The National Park Service realized at the onset of the planning process that the alternatives must include a formal monitoring plan to adequately assess the effectiveness of the project and its effects on other park resources. Therefore each action alternative includes a monitoring plan that identifies specific parameters that would be evaluated during and after the restoration activities.

ECOLOGICAL REFERENCE CONDITIONS

The National Park Service has identified reference conditions that each alternative would be measured against to indicate the level of restoration success. Reference conditions are based on site-specific historical knowledge of resource conditions within and in the vicinity of the project area or on regional reference conditions found in areas of the western slope in Colorado. For planning and restoration assessment, ecological reference conditions were based on the work of Potter (2011) and Johnston et al. (2001). Potter's (2011) work is based on very similar physical, ecological, and climatological settings in northern Colorado as well as sites in the impact areas, while Johnston et al. (2001) describe systems present in the upper Gunnison Basin of Colorado. Both studies address wetland, riparian, and upland plant communities very similar to those in the study area. Potter (2011) presents more quantitative estimates of groundwater depths, while Johnson et al. (2001) provide more details regarding the plant species compositions and soil and other physical characteristics associated with the plant communities. As additional studies of site conditions are completed in the restoration areas, a better understanding of the important physical and biological interrelationships needed to achieve the reference conditions will be achieved.

Potter (2011) surveyed vegetation, depth to groundwater, and soil texture relationships at four wetland and riparian sites adjacent to or near the impacted area and at 10 wetland and riparian sites elsewhere in northern Colorado comparable to the area impacted by the 2003 Grand Ditch breach. Each site was surveyed for stream gradient, depth to groundwater, soil, vegetation, and streamflow. Based on the information gathered from these reference sites, a range of design parameters and specifications for three of the four zones was determined. The parameters include depth to groundwater, soil texture, and vegetation assemblages. Because Potter's (2011) findings are preliminary, the following recommendations indicate what ecological reference conditions might be, and they could be a foundation for the final future design specifications. Table 2.1 presents Potter's (2011) preliminary recommendations.

Table 2.1: Preliminary Reference Conditions for Restoration Areas

Restoration Area	Average Depth to Groundwater (inches)	Soil Texture	Dominant Plant Species[a]
Zone 2, Lulu Creek riparian areas	20	Coarse sandy loam	*Salix* spp.
Zone 2, Lulu Creek upland areas	21	Coarse sandy loam	Overstory of *Picea engelmannii* and *Abies bifolia*; understory of *Vaccinium angustifolium*, *Mertensia ciliata*, *Senecio triangularus*, and *Arnica cordifolia*.
Zone 3, Colorado River riparian area	18	Clay loam and sandy clay loam	*Salix geyeriana*, *Salix drummondiana*, *Alnus tenuifolia*, *Carex utriculata, Carex aquatilis*, and *Populus angustifolia*
Zone 4, Lulu City wetland	24	Sandy loam and sandy clay loam	*Salix drummondiana, Salix monticola*, *Salix planifolia, Calamagrostis canadensis*, *Carex aquatilis*, and *Carex utriculata,*

a. Listed in approximate order of decreasing dominance.
Source: Modified from Potter (2011).

Johnston et al. (2001) profiled the biological characteristics, soils, water, and other physical characteristics associated with 32 ecological series (an example series is lodgepole pine). Six series were selected to define the approximate vegetation goals in each restoration zone: lodgepole pine (for zones 2 and 3), subalpine fir – Engelmann spruce (zones 2 and 3), riparian blue and Engelmann spruces – subalpine fir (zone 3), Drummond willow–mountain willow–booth willow (zone 4), planeleaf willow–wolf willow–bog birch (zone 4), and water sedge (zones 3 and 4). These series established general vegetation species composition and structural characteristics, as well as the associated soil, gradient, and water relationships needed to develop and sustain each series. Exact matches between the restoration and the reference conditions would not be expected because ecological complexities prevent duplicating the same conditions at any two locations. Table 2.2 provides the typical dominant plant species, soil textures, and depth to groundwater conditions reported by Johnston et al. (2001) for the ecological series most similar to conditions in the areas affected by the 2003 breach. Future restoration design steps will need to consider the natural variability when planning detailed measures to achieve these reference conditions.

Table 2.2: Preliminary Reference Conditions for Upland, Riparian, and Wetland Restoration Areas

Restoration Area	Community Type	Average Water Table Conditions	Soil Texture	Dominant Vegetation Species[a]
Zone 2, Lulu Creek riparian area	Riparian blue and Engelmann spruces–subalpine fir	Stream gradients are high enough that most of the water is in the stream and never ponds on the banks.	A variety of surface textures; subsurfaces are sandier, such as sandy clay loam or sandy loam.	*Picea pungens, Picea engelmannii, Abies lasiocarpa, Alnus incana ssp. tenuifolia, Calamagrostis canadensis, Mertensia ciliate, Senecio triangularis*
Zone 2, Lulu Creek upland area	Lodgepole pine	Soil surface is dry year-round, even under snow. A little moisture is retained by litter and duff.	Surface is clay, sandy loam; sandy clay loam, clay loam, sandy clay subsurface.	*Pinus contorta, Vaccinium myrtillus, Carex geyeri, Arnica cordifolia, Lupinus argenteus*
	Subalpine fir–Engelmann spruce	Soil surface is dry year-round, even under snow. A little moisture is retained by litter and duff.	Surface is loamy sand or clay loam; loamy sand, sandy clay, or sand subsurface.	*Abies bifolia, Picea engelmannii, Carex geyeri, Vaccinium myrtillus, Arnica cordifolia*
Zone 3, Colorado River riparian area	Riparian blue and Engelmann spruces–subalpine fir	Stream gradients are high enough that most of the water is in the stream and never ponds on the banks.	A variety of surface textures; subsurface materials are sandier, such as sandy clay loam or sandy loam.	*Picea pungens, Picea engelmannii, Abies lasiocarpa, Alnus incana ssp. tenuifolia, Calamagrostis canadensis Lonicera involucrata, Cornus sericea*
Zone 4, Lulu City wetland, including wetlands in lower Zone 3	Drummond willow–mountain willow—booth willow	Water table is high throughout the year; standing water occurs in the lowest micro sites through the growing season.	Surface is silty loam; subsurface is a wide variety of silty, clayey, and loamy textures.	*Salix drummondiana, Salix monticola, Salix boothii, Carex utriculata, Calamagrostis canadensis-*
	Planeleaf willow—wolf willow–bog birch	Water table is high throughout the year; standing water occurs in the lowest micro sites through the growing season.	Surface organic to silty (silty clay loam-silty loam-silty clay); subsurface is a wide variety of textures.	*Salix planifolia, Salix wolfii, Betula glandulosa Carex aquatilis, Deschampsia cespitosa*
	Water sedge	Water is at the surface or ponded on surface most of year.	Surface organic material; subsurface gleyed with clay or sandy clay loam.	*Carex utriculata, Carex aquatilis, Deschampsia cespitosa*

a. Listed in approximate order of decreasing dominance.
Source: Johnston et al. (2001)

Table 2.3: Preliminary Reference Conditions for Stream Channel Restoration Areas

Restoration Area	Channel Slope (percent)	Average Channel Width at Top of Bank (feet)	Average Channel Depth (feet)	Step-Pool Interval (feet)	Pool Spacing Between Riffles (feet)	Effective Discharge (cubic feet per second)
Zone 2, Lulu Creek	5 to 20	8 to 16	To Be Determined	10 to 15	---	To Be Determined
Zone 3, Colorado River	1.1 to 1.5	17 to 20	1.5 to 2.8	---	125 to 205	65 to 75
Zone 4, Colorado River through Lulu City wetland	0.8 to 1.0	20 to 31	1.5 to 2.8	---	170 to 230	106 to 116

Sources: Anderson and Rathburn (No Date), Rathburn (2006), Rathburn (2010), Rathburn (2012)

For planning and restoration assessment, ecological reference conditions for the Lulu Creek and Colorado River channel geometric conditions, streambanks, streamside vegetation, and instream woody materials were based on the investigations of Anderson and Rathburn (No Date), Rathburn (2007, 2009, 2010, and 2011a), and Rathburn et al (2011) for Sawmill Creek, Lulu Creek upstream of the confluence with the breach gully, and the Colorado River upstream of its confluence with Lulu Creek. These investigations established stream channel slope and general physical conditions, step-pool spacing and configurations, streambank vegetation species, the range of flow conditions throughout the year, and channel bedload conditions.

Because the investigation findings are preliminary, the following target conditions indicate what ecological reference conditions might be, and they could be a foundation for the final future design specifications. The important reference condition metrics for stream restoration are summarized in table 2.3. Average channel depth is defined as the vertical distance from the top of the channelbank to the average channel bottom depth along the channel cross-section. The effective discharge is the discharge or range of discharges that transports the largest proportion of the annual suspended sediment load over the long term (Wolman and Miller 1960). Historical photographs of the Lulu City wetland indicate that in 1937, the Colorado River had a meandering channel flowing through the central portion of the wetland, and sediment was associated with river bars and beaver ponds. According to Cooper (2007c), the wetland would have had tall willows and alders that supported beaver populations. This represents the reference condition for the wetland in zone 4: a central river channel, the water table near the surface to support a vegetation community of tall willows and alders, and populations of beaver.

For other attributes of the restored environment, other metrics would be relied upon to establish the reference condition. For example, water quality is the cumulative result of physical, chemical, and biological processes operating and functioning interactively to produce a water quality condition. As biological and chemical conditions change seasonally and annually, water quality changes accordingly.

A qualitative approach for evaluating water quality conditions of riparian-wetland areas as a function of hydrology, vegetation, and site stability is the proper functioning condition assessment method developed by the Bureau of Land Management (Prichard 1998). This method assesses how well the physical process are functioning based on quantitative sampling techniques and qualitative information to produce benefits such as stream channel stability and good water quality when it is in a proper functioning condition.

A riparian-wetland area is considered to be in proper functioning condition when adequate vegetation, landform, or large woody debris is present to

- dissipate stream energy associated with high water flow, thereby reducing erosion and improving water quality;
- filter sediment, capture bedload, and aid floodplain development;
- improve flood-water retention and groundwater recharge;
- develop root masses that stabilize streambanks against cutting action;
- develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and
- support greater biodiversity.

The components of this definition are listed in order relative to how processes work on a site. Once restoration activities were completed, periodic field assessments of the area's hydrology, vegetation, and soil conditions would be required to determine when proper functioning conditions had been achieved. Water quality monitoring would be conducted to track and confirm that a properly functioning condition (and ecological reference condition) had been achieved for water quality.

Resource Recovery Based on Restoration Actions

Figure 2.1 shows a conceptual model of the trend for restoration of ecological processes over time for each alternative. The restoration progress curves represent the best estimate of the approximate percent restoration of ecological processes to reference conditions through time for each alternative. Recognizing that some processes and site conditions can be restored faster than others, the curves represent a composite, or best fit of the different individual restoration elements. For example, restoring willow areas to reference or pre-breach conditions can be substantially accomplished in 20 to 25 years, restoring channel conditions to reference conditions can be accomplished in 2 to 5 years, and restoring forested areas to reference conditions could take 200 to 350 years. Each curve accounts for these differences by considering and balancing the quantity and relative proportion of each type of restoration to be accomplished, the time required to fully achieve each type of restoration, and the final reference condition to be achieved. Because forest restoration to the late successional stages or old-age tree classes that existed before the breach would take the longest time, none of the alternatives would achieve full restoration within 200 years. Full forest recovery might take up to 350 years. Alternatives C, D, and E show the most rapid relative recovery because revegetation and other site improvement steps would be taken (such as planting older tree saplings) to accelerate forest recovery. Alternatives A and B show an initial delay with prolonged and slower system recovery caused by relying primarily on natural processes to accomplish restoration to reference conditions.

METHOD FOR ARRIVING AT ALTERNATIVES

Starting in the summer of 2003, Rocky Mountain National Park and a team of cooperating researchers conducted surveys to assess the nature and extent of the injury caused by the breach. Assessment focused primarily on characterizing debris and sediment deposition characteristics, stream channel morphology, groundwater elevations, hydrology, aquatic conditions, and impacts on wetland, riparian, and upland vegetation. The area of impact to be analyzed was determined by the approximate extent of deposition of debris and injury to vegetation; it was divided into five zones representing different hydro-ecological areas. The stability of the gouge in the steep hillside immediately below the breach site was also investigated. Since the 2008 settlement, additional assessments have refined the understanding of the area's current hydrology, including stream hydrology, sediment transport and deposition, surface water–groundwater interactions, groundwater elevations, and wetland changes. To identify specific areas within each zone where restoration actions would occur, an evaluation process was employed to identify action criteria and ecological reference conditions to guide the restoration choices. The interdisciplinary team established restoration objectives based on ecological reference conditions for the project area that could be accomplished under each alternative in each zone. All of the action alternatives consider bank stabilization to some degree. Bank stabilization refers to reshaping banks and, to some degree, placing rocks or other available materials (e.g., cobbles or large woody debris) to lessen the availability of breach debris and sediments to the system. Under alternatives where smaller-scale restoration activities would take place (alternative B), the planning team applied the action criteria to identify those areas that would undergo restoration actions to achieve a high level of bank stabilization and that would be sustainable over the long term. Under alternatives C, D, and E, restoration actions would include removing larger amounts of debris and sediment, stabilizing additional areas, and planting willows and other species to achieve ecological reference conditions to a large degree. In recognizing the dynamic nature of streams, the park does not intend to prevent changes to the stream channels as a result of natural processes such as erosion. Rather, the goal of the restoration action is to prevent transportation downstream of unnatural amounts of debris and sediment resulting from the breach and to allow for the channels to migrate laterally, as would occur under natural conditions. To determine site-specific locations for action, the ecological reference conditions of each zone were used to guide the proposed restoration activities for each alternative. In addition to using these planning tools, scientists who are most familiar with the conditions in the project area were consulted to identify areas where restoration actions would take place.

The quantities of debris that have been identified in the action alternatives for recontouring or excavation are based on an assessment of the distribution and depth of sediment currently present within the zones, as indicated by site-specific field investigations, including the results of surveys using ground-penetrating radar and recent aerial photographs (2008–2010). Natural hydrologic, erosion, and sediment mixing processes have redistributed portions of the material deposited by the 2003 event downstream of its original location. Therefore, the current estimates of the amount of debris to be excavated or treated are different from the estimated volumes identified immediately following the breach (presented in table 1.1). This is due to several factors.

First, not all of the debris that was deposited within a zone would need to be removed because some areas have stabilized to a large degree since the breach occurred. For example, some of the debris within zone 2 would be left in place to form the channel and channelbanks of Lulu Creek. In these locations, the planning team concluded that disturbing the relatively stable channel gradient and other channel morphological conditions would generate unacceptable channel instability and would not produce much additional long-term improvement.

Second, some of the debris originally deposited as an alluvial fan in lower zone 2 and upper zone 3 has been transported downstream to zones 3 and 4. Therefore, the estimated amount of material to be removed as part of restoration activities in the alluvial fan area would not be as large as was previously estimated.

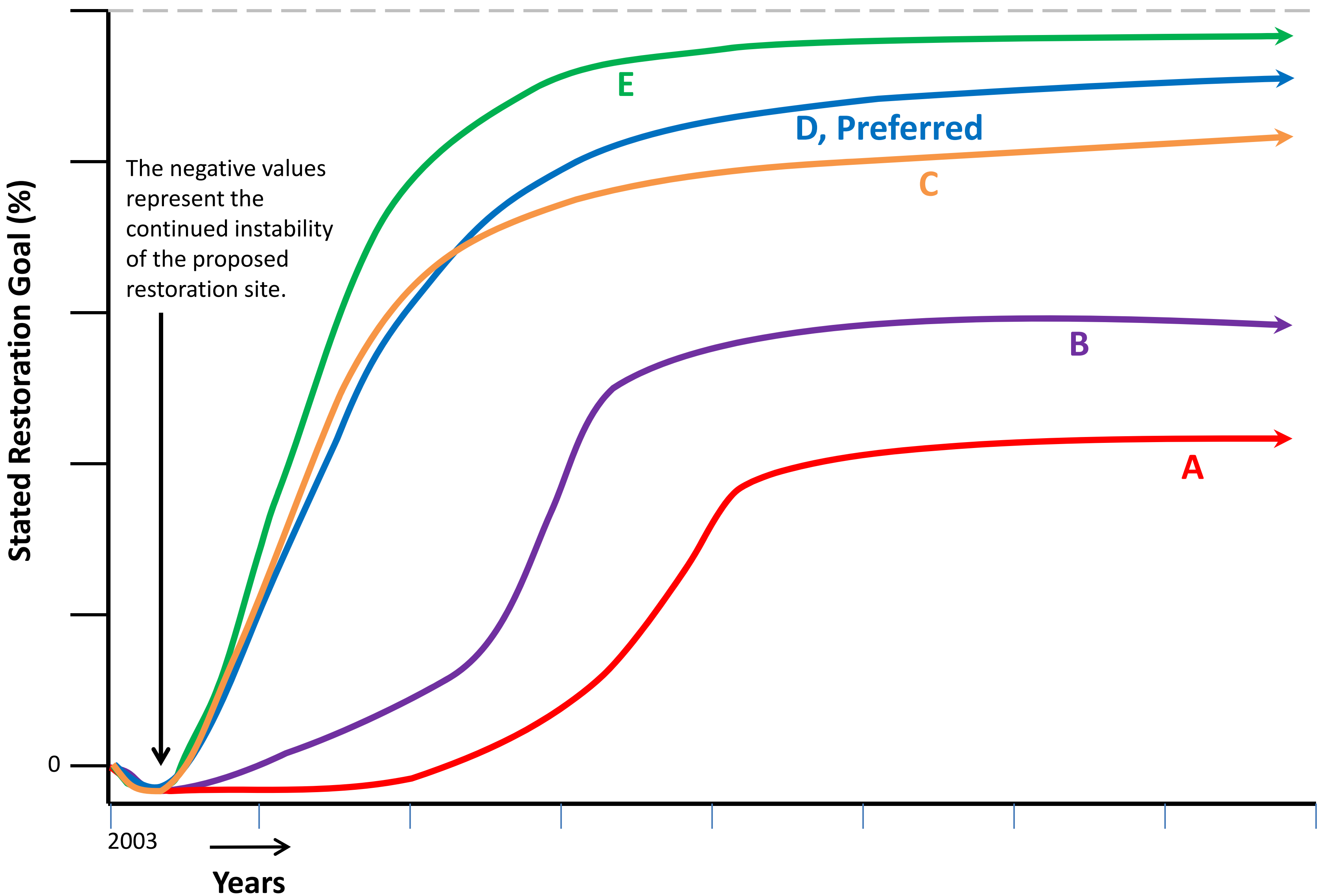


Figure 2.1: Conceptual model for estimated restoration progress of ecological processes by alternative

Third, the amount of 2003 debris to be removed from zone 4 in the future would be greater than the initial 2007 estimate of about 10,000 cubic yards. This difference is due to additional investigations that produced a more detailed understanding of the 2003 debris deposition patterns and depths as well as to the constant importation and deposition of materials into zone 4 from upstream (noted previously). To illustrate this point, debris deposition investigations in the Lulu City wetland in 2009 suggested that approximately 14,400 cubic yards of 2003 debris (Potter 2010a) and about 82,000 cubic yards of total debris for all past debris flow events (Potter 2011) were present in the wetland at that time. Based on 2010 and 2011 field inspections, the high spring runoffs of 2010 (a 30-year flow event) and 2011 (a 60-year flow event) transported additional sediment into the wetland, have further changed the previous 2009 estimates.

Finally, sediment quantities to be removed would also differ from the 2003 estimate because in order to achieve the intended wetland ecological reference condition, additional surface excavation would be required to create the hydrologic functions and flows needed in the wetland and relocated river for long-term ecological sustainability of the restored wetland. Restoring the Colorado River to its reference condition through zone 4 wetland would require sediment alterations that were probably not included in the initial estimate for this zone.

For these reasons, the quantities of sediment to be excavated and recontoured by the current alternatives would not be expected to match exactly the quantities of debris and sediment that were estimated in 2007 for the 2003 breach.

Using the large body of ecological knowledge gathered in the park, similar scientific information from other reference areas, and the requirements of the 2008 settlement, the National Park Service developed alternatives that combine diverse restoration tools and approaches to achieve the restoration objectives.

A set of maps at the end of this chapter shows the approximate location within each zone where restoration activities would occur (figures 2.2 through 2.29, at the end of this chapter). The areas represented on the figures do not represent precise locations of an activity but rather represent where actions could occur at a conceptual level. This allows the calculation of approximate areas being treated or disturbed. Areas not identified on the figures would be left untreated. In addition, there are a few areas identified on the figures (areas D, J, and R) where no actions are proposed. These areas were initially identified as potential areas for restoration at the beginning of the alternative development process. However, based on information from scientists and park staff who are knowledgeable of the project area, these locations were determined to be stable or unaffected by the breach, and therefore no restoration activities would be required. They continue to be depicted on the figures to support information in the project administrative record.

The alternatives are conceptual, schematic designs that present the principal elements of each alternative's restoration approach and emphasize the physical and functional relationships of project components throughout the project area. The design for each alternative is approximately 15% of final design and is developed to a level of detail suitable to:

- Evaluate the ability of the alternative to achieve restoration objectives,
- Estimate implementation costs, and
- Analyze the environmental impacts.

After the National Park Service has selected a final alternative, the design process will continue and engineers will develop final designs and construction documents that will specify the full detail for implementing the selected alternative.

Table 2.5 (at the end of this chapter) includes costs for each alternative. The costs were developed as a Class C estimate (conceptual design or order-of-magnitude estimates) and included many assumptions about the ways and extent of the work to be conducted. The accepted industry accuracy range of Class C estimates is -30% to +50% (NPS 2007b). Refer to appendix E for the full cost matrices used to evaluate the alternatives. The costs were developed in 2011 dollars using the best available information at the time, and are not intended to represent the cost of the project upon implementation. Rather, they are presented as a means to compare the alternative costs relative to one another.

Choosing By Advantages

The NPS uses a selection and ranking process that is based on the relative advantages and costs of alternatives in accomplishing defined project goals and objectives. This process is called Choosing By Advantage (CBA). In using the CBA process, the NPS asks itself, "What and how large are the advantages of each alternative?" proposed for consideration, "How important are the advantages of the projects?" and finally, "Are those advantages worth their associated cost?"

The Interdisciplinary Team (IDT) assigned to the Grand Ditch Breach Restoration project and other subject matter experts conducted a facilitated CBA workshop on March 30 -31, 2011. A follow-up conference call was conducted on May 16, 2011 to complete the CBA process. The outcome of the CBA workshop was that the IDT defined the preferred alternative as a combination of restoration activities derived from the Alternatives B through E as originally developed. This newly derived alternative became the NPS preferred alternative in the Draft EIS. A "Choosing by Advantages Draft Workshop Meeting Report" was prepared in June 2011 to describe the methodology used to evaluate the alternatives and to derive the NPS preferred alternative. The Draft Workshop Meeting Report is on file and is available upon request.

A briefing was held for the Intermountain Regional Director on January 27, 2011 that affirmed the recommendations of the IDT.

ALTERNATIVE A – NO ACTION ALTERNATIVE / CONTINUE CURRENT MANAGEMENT

Alternative A would involve the continuation of current management of the area impacted by the 2003 Grand Ditch breach. Alternative A represents current conditions and is therefore the baseline against which the action alternatives are compared.

The National Park Service would continue current management of the impacted area, following existing management policies and NPS guidance. The area would continue to be protected as a National Park and under the Wilderness Act. However, the park would not undertake any active restoration but would continue to rely on natural processes to restore the hydrologic conditions and biotic integrity of the area. The degree of restoration under alternative A over time in relation to ecological reference conditions is presented in figure 2.1.

It is expected that university-based research projects would continue in the area and that NPS monitoring of resource conditions would continue to occur annually.

This alternative is likely to violate the court mandate to stabilize zone 1A, as stipulated in the 2008 settlement between the United States and the Water Supply and Storage Company.

Alternative A is represented on figures 2.2 through 2.7 at the end of this chapter. Please note that the quantities presented on the figures are based on the initial estimates of debris that was deposited in the zones.

ACTIONS COMMON TO ALL ACTION ALTERNATIVES

VEGETATION RESTORATION

The restoration of vegetation within the project area would occur to varying degrees under each of the alternatives. At a minimum, the following would be conducted:

Seeding using native seed of the same germplasm as those found west of the continental divide would be used primarily in zones 1B, 2, and 3 to stabilize disturbed areas resulting from the breach or from restoration actions. This would be accomplished through seeding with native plant seed and through either applying erosion control blankets or covering with wood fiber mulch. In areas where sufficient soil exists to allow propagation of seed, hand tools or mechanized equipment would be used to prepare the designated surfaces for receiving seed. The seed would be sown at the recommended prescribed rate, as determined by the park botanist. To maintain the seed in place, natural fiber erosion-control blankets would be used to hold the seed until germination. The erosion blankets would be secured using manufactured stakes and available cobbles where feasible. If needed, additional anchoring would be placed across the blanket. Given the climate and environmental conditions (e.g., precipitation, temperature) the erosion control blankets would degrade in place over three to six years, and degradable stakes used to secure them would also be left to gradually decompose.

Where seedlings of trees, shrubs, and other native vegetation species are planted, hand tools would be used to excavate necessary areas, opening the erosion control blanket where necessary. The soil surface around plantings would be tamped to minimize erosion potential, and the blanket would be closed over the rootball.

In the wetland locations, sod, sprigs of sedges and wetland grass species, or cuttings of tall willows would be planted, depending upon the alternative. Sprigs are bare-root plants that would be planted to revegetate bare areas. A sprig typically includes one to three individual plants of a single species that are planted together in a single hole. Sprigs are planted by hand by opening a narrow trench 8 to 10 inches deep with a shovel or spade, inserting the sprig so the top of the root crown remains level with the ground surface, and compacting the trench around the sprigs roots. Sprigs of sedges would be grown from seed collected from existing wetlands in the field and would be grown by the National Park Service or a contract nursery to maintain the genetics of the wetlands.

Willow cuttings are typically planted in the late fall or early spring. The cuttings (or whips) are the terminal ends of willow branches that typically are cut from existing willow shrubs. If whips are harvested from local willow stands, the cuttings would not remove more than 10% to 20% of the total canopy of a plant. Whips would typically be about 3 to 4 feet long and about 0.50 to 0.75 inches in diameter at the cut end. If the cuttings are collected just before planting and while the stems are dormant, storage facilities would not be required. Cuttings would be planted by hand by pushing the cut end of the whip directly into moist or wet soil so that no less than half the whip length goes into the ground. The whip would need to extend deep enough so it would contact the midsummer water table. Before planting, the whip's apical bud would be removed to encourage the stem to produce roots and leaves during its first growing season. Cuttings would be planted at a spacing of 1 to 3 feet. The whip's cut end would need to be kept wet or moist between the time it is cut and then planted to increase its rooting and survival probability. No follow-up treatment would be required after the whips are planted.

Sod squares of wetland sedges, rushes, and hydric grasses can be used to quickly revegetate bare or disturbed wetland areas or to serve as sources of seed for the immediate area. Sod is typically obtained from local wetlands of the preferred type during early spring, or it can be salvaged from a project location where wetland vegetation is being removed. Sod blocks are typically 6 to 12 inches square and about 6 to 10 inches thick. The root mass should remain protected by a soil matrix. Sod blocks can be planted in various patterns and spacing to meet the desired vegetation restoration objectives and schedule. A sod block would be planted to maintain the same ground surface elevation and general soil moisture conditions as the site where it came. Sod blocks can be stored temporarily before planting, as long as the soil matrix is keep moist and the roots are protected from drying out.

Areas seeded or planted with native vegetation would be watered for the first year of establishment, where necessary and feasible, to maximize survival rates.

Existing vegetation that would be destroyed by restoration implementation may be salvaged, stored in temporary nurseries, and reused during vegetation restoration post restoration implementation. All plant material used in this restoration action would need to meet the genetic similarity requirements of the park's current vegetation restoration management plan (NPS 2006b).

Revegetation of disturbed soil areas would be facilitated by salvaging and storing existing topsoil and reusing it in restoration efforts in accordance with NPS policies and guidance.

In addition to these actions, the National Park Service would continue to treat and manage exotic or nonnative plant species in the project area in compliance with the park's exotic plant management plan (NPS 2003b).

RESTORATION IMPLEMENTATION

Under all alternatives, restoration activities would be conducted in the summer after the peak runoff and before significant snowfall. The timeframe would generally be June through September during daylight hours during the week. The duration of restoration activities varies by alternative and is described further under each action alternative. Work crews would be housed in the project area when possible to reduce travel into and out of the area. However, the number of workers, duration of site occupation, housing, and support infrastructure requirements would differ for each alternative.

MINIMUM REQUIREMENT ANALYSIS

All action alternatives, including some of the slope stabilization in zone 1A, would involve activities in designated wilderness areas within the park. Therefore, in accordance with the Wilderness Act and NPS policies, the National Park Service must complete a minimum requirement analysis before taking management actions. This discussion analyzes whether management actions affecting wilderness character are necessary, as well as how to best minimize impacts. The minimum requirement analysis is a two-step process. The first step determines whether the proposed action is appropriate or necessary for administration of the area as wilderness and whether it poses significant impact on wilderness resources and character. The second step analyzes the techniques and types of equipment needed for the action to minimize impact on wilderness resources and character. The alternatives for restoration of the impacted area include activities or the use of tools that would be subject to a minimum requirement analysis. Each alternative description discusses the specific activities and/or tools that would be subject to such analysis. This analysis has been completed for the elements associated with the action alternatives and is appended to this environmental impact statement in appendix F.

RESOURCE MONITORING

A detailed monitoring plan would be incorporated into the detailed restoration design. Under this plan, the effectiveness of specific restoration actions and resource conditions would be monitored over the next 20 years, and longer if deemed necessary based on monitoring results. The frequency of monitoring would be high in early years and may decrease later if less frequent data collection is found to be sufficient. Under each action alternative, changes in stream and groundwater hydrology, channel morphology, water quality, and vegetative recovery would be monitored in the restoration area to measure restoration effectiveness. Monitoring would also evaluate mitigation measures and best management practices for effectiveness in reducing adverse effects on resources. Monumented photopoints and photopoint plots will be taken for each of the parameters being monitored. The following list identifies the parameters that may be monitored for each major restoration element:

1. Vegetative Recovery
    a. Sedges and other herbaceous plants
        i. Establish permanent plots and monitor
            1. Survival by species over time
            2. Spread of clonal plants using small plots to monitor number of shoots of species
            3. Percent cover of all species (by species)
            4. Seed rain/seed transport into the plots
            5. Establishment of species that were not planted
    b. Willow and other woody plants
        i. Survival of the plantings
        ii. Increase in number of live stemson willows
        iii. Willow seed rain into plots
        iv. Height of woody plants for tagged individuals
        v. Herbivory in plots
2. Hydrology
    a. Groundwater/surface interactions.
        i. Stream staff gauges and groundwater monitoring wells in plots to be measured
        ii. Use of loggers and work to understand how stream and groundwater levels co-vary
        iii. Depth to groundwater suitable for plant communities to be restored
3. Stream Channel and Water Quality
    a. Stream morphology
        i. Cross-sectional measurements of stream channel geometry
            1. Width:depth, step height and spacing, channel gradient, in-stream wood
            2. Compare to geometry measurements of reference reaches
        ii. Streamflow rates
            1. Relative to bankfull and highest flow on record (2011)
    b. Sediment Transport and Bed Material
        i. Sediment supply vs. capacity analysis for bedload (Soar and Thorne 2001) on Colorado River at all gage stations, and historical channel through wetland
        ii. Pebble counts at each gaging station compared to reference reaches
        iii. Core samples and riffle stability index measurements
        iv. Trout pool habitat
            1. Number of pools, pool quality, and fine sediment content
    c. Turbidity
        i. Suspended sediment concentrations

d. Water quality
   i. Nitrogen and phosphorus forms
   ii. Trace metals
   iii. pH
      1. Diurnal fluctuations and exceedances of over 9.0
   iv. Macroinvertebrate sampling
   v. Periphyton sampling

EDUCATION

Under all action alternatives, public education efforts would be developed to provide information about the restoration action taking place in the project area. The education component of the project could include the following:

- Interpretive programs about the resource issues, restoration actions selected, research activities, and status of the restoration effort
- Articles placed in the park newsletter and local newspapers
- Annual reports on restoration efforts and research activities
- Postings on the park and NPS websites, possibly including links to research papers and any monitoring results
- Wayside signs describing the restoration efforts at trailheads near the project area

MITIGATION MEASURES AND BEST MANAGEMENT PRACTICES

Congress charged the National Park Service with managing the lands under its stewardship "in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (NPS Organic Act, 16 USC 1). As a result, NPS staff routinely evaluate and implement mitigation measures whenever conditions could adversely affect the sustainability of national park system resources.

Impact avoidance and mitigation measures refer to measures and practices adopted by a project proponent to reduce or avoid adverse effects that could result from restoration activities. The Council on Environmental Quality recommends consideration of five types of mitigation measures: avoiding, minimizing, rectifying, reducing, and compensating (40 CFR 1508.20).

To ensure that implementation of the action alternatives protect natural and cultural resources and the quality of the visitor experiences, mitigation measures have been identified for each action alternative. Mitigation measures that are typical for this type of proposed restoration project are discussed in this section and include use of best management practices to avoid, minimize, or reduce the impact from construction. In some cases, mitigation measures were incorporated into the design of the alternatives and are not specifically identified. Various best management practices would be adopted as part of the selected alternative and would be incorporated into restoration plans and specifications, providing a contractual requirement that any contractor retained for any phase of the action would abide by the conditions and procedures identified in this document and permits. Those typical mitigation measures that could be applied under each of the action alternatives are described below. Additional alternative-specific mitigation measures have been identified and are discussed under each alternative. Mitigation measures would be refined as the design of the project develops and as permit conditions are defined by the regulatory agencies. Some mitigation measures protect or benefit multiple resources. For example, mitigation measures intended to minimize water turbidity also benefit fish and some special status species, as well as water quality. Therefore, measures for interrelated resource categories should be reviewed to fully understand the scope of the proposed mitigation.

Measures to Protect Water Quality

During implementation of the selected alternative, the following stipulations to protect water quality within and downstream of the project area would be completed:

- Conduct construction work in accordance with site-specific construction plans that minimize the potential for increased delivery of sediment to surface waters.
- Minimize removal of and damage to native vegetation.
- Install temporary construction fences to identify areas that require clearing, grading, revegetation, or recontouring.
- As appropriate, implement erosion control measures to prevent sediment from entering surface waters, including the use of silt fences or fiber rolls to trap sediments.
- Dispose of volatile wastes and oils in approved containers for removal from the project site to avoid contamination of soils, drainages, and watercourses.
- Except as required by the restoration plan, dispose of excavated and excess sediment in upland storage areas that prevent runoff from entering nearby water bodies.
- To the extent practicable, conduct work activities in wetlands and streams during the low-flow periods of the year.
- Minimize the operation of construction equipment in flowing water.
- To the extent practicable, route surface water around or away from active excavation or filling activities.

Measures to Protect Wetlands

- Temporary stockpiles in wetlands must be removed in their entirety as soon as practicable. Wetland areas temporarily disturbed by stockpiling or other activities during restoration must be returned to their preexisting elevations, and soil, hydrology, and native vegetation communities must be restored as soon as practicable.
- Care must be taken to avoid any rutting by vehicles or equipment. The operation and movement of construction equipment will be restricted to defined work areas.
- To the extent practicable, conduct construction activities during the low-water period of the year.
- Restrict work areas to the smallest area required to implement the restoration plan.

Measures to Protect Special Status Species

Mitigation measures to offset, minimize, or avoid adverse impacts on special status species would include the following:

- Before initiating restoration activities in the project area each year, perform snow surveys looking for lynx (Lynx canadensis) and wolverine (Gulo gulo luscus) tracks or sign to determine if lynx or wolverine may be present. If tracks or other sign are found, undertake a more in-depth survey to determine if a den or breeding pair may be in the area. If a den or breeding pair is found, initiate consultation with the U.S. Fish and Wildlife Service to determine necessary mitigation measures and a course of action that would not result in adverse effects on the lynx or wolverine.

- Keep on site a pocket guide of the special status species that would include pictures as well as track and scat identification guides for the restoration crew to refer to when or if they encounter potential sign of special status species. This guide would also include names and radio numbers on whom to contact if a positive identification were made.

- Brief the crew each season about special status species and what to look for via a PowerPoint presentation. This would include any contractors or park staff working on the project.

- Three state-listed aquatic species that occur within the project area are the endangered boreal toad (*Bufo boreas boreas*), the wood frog (*Rana sylvatica*), and the Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*), all state species of special concern. To prevent adverse impacts on these species, the National Park Service would conduct clearance surveys for these species annually before implementing restoration activities. Individuals of these species that have moved into the project area would be captured and relocated to habitat outside of the project area.

- A monitoring plan would be prepared and approved by the National Park Service prior to starting any restoration activities that could adversely affect special status species and their habitats.

Measures to Protect Wildlife

- People or equipment entering the project site or moving from one wet area of the project to another may be required to disinfect their boots and equipment to stop the spread of zoonotic diseases. These are diseases that are transmissible between animals and humans, such as whirling disease (affects trout) and chytrid fungus (affects amphibians). At a minimum, disinfect all equipment before being brought into the project site and if it leaves the project site and then returns.

- Delineate helicopter flight paths to ensure minimal disturbance to bighorn sheep and any other sensitive wildlife species. An NPS-resource specialist would consult with helicopter pilots and restoration managers to determine a suitable flight path with minimal impacts on wildlife before implementation of restoration activities.

- Properly store all food and food-related trash at the temporary work crew camps to prevent black bear (or any other potential scavengers) from gaining access. This may involve placing tents, the cooking shelter, and trash inside a fenced enclosure.

- A monitoring plan would be prepared and approved by the National Park Service prior to starting any restoration activities that could adversely affect trout and other aquatic species and their habitats.

- The year before construction activities start, the National Park Service will complete a breeding bird survey, by a qualified biologist, in the proposed work areas to survey for endangered, threatened, and candidate species listed on the unit-specific endangered and threatened species list and also for species listed on the state endangered, threatened, and species of concern list. If any of these birds are noted in the project area a determination on how to best protect them when construction starts the following year will be completed. During construction, it may be necessary to implement appropriate impact mitigation measures, such as a protective buffer zone around a nesting pair of birds or temporarily rescheduling activities.

Measures to Protect Vegetation and Prevent the Introduction and Spread of Invasive Plant Species

Best management practices to protect vegetation during restoration activities would be incorporated into plans and specifications for the proposed action. They would include, but may not be limited to, the following:

- Require the use of temporary construction fences to delimit work areas. Require that fences be installed before site preparation work or earthwork begins.
- Exclude foot and vehicle traffic from particularly sensitive areas by delimiting exclusion areas with temporary construction fences and flagging tape in a conspicuous color.
- Wash off the tires or tracks of trucks and equipment entering and leaving project sites to prevent seed transport.

Spill Prevention and Response Plan

A spill prevention and response plan that regulates the use of hazardous and toxic materials, such as fuels and lubricants for construction equipment, will be prepared. The National Park Service would oversee implementation of the spill prevention and response plan. Elements of the plan would ensure that:

- Workers are trained to avoid and manage spills.
- Construction and maintenance materials are prevented from entering surface waters and groundwater.
- Green (biodegradable) hydraulic fluids and oils are used on mechanical equipment.
- A spill kit with boom and sorbent materials are on site at all times during construction.
- Spills are cleaned up immediately and appropriate agencies are notified of spills and of the cleanup procedures employed.
- Staging and storage areas for equipment, materials, fuels, lubricants, solvents, and other possible contaminants are located at least 100 feet away from surface waters.
- No vehicles would be fueled, lubricated, or otherwise serviced within 200 feet of the normal high water area of any surface water body.
- Vehicles would be immediately removed from work areas if they are leaking.

Measures to Protect Natural Quiet and Soundscapes

The following measures would be implemented to reduce noise and lessen the impacts of noise that cannot be avoided.

- Require construction equipment to have sound-control devices at least as effective as those originally provided by the manufacturer, and no equipment would be operated with an unmuffled exhaust.

Measures to Protect Air Quality

- Implement vehicle emissions controls such as keeping equipment properly tuned and maintained in accordance with manufacturers' specifications and implementing best management construction practices to avoid unnecessary emissions (e.g., engines would not idle).
- To the degree possible, mitigate impacts by the use of best management practices to reduce generation of dust, such as covering loose soil and watering activities.

Measures to Protect Cultural Resources

- While the proposed alternatives would not appear to affect documented resource areas, an NPS employee would be on call to ensure that restoration activities do not impact cultural resources that have not been previously documented. If resources are discovered, the National Park Service would act immediately and appropriately as documented in 36 CFR 800.13 "Post-review discoveries" (http://www.achp.gov/regs.html #800.13).

Measures to Protect Recreational Use

- The National Park Service would take feasible measures to minimize the effects of restoration activities on recreational use. Information on upcoming closures, including closure dates and arrangements for alternate trail access points, would be posted on the park website, distributed at the Kawuneeche Visitor Center, and posted at the Colorado River Trailhead and at the project site. Information on alternate recreational opportunities would be publicized on the park website, in the park newsletter, and in signage at the trailheads when closures are necessary.

ALTERNATIVE B – MINIMAL RESTORATION

Alternative B would emphasize a smaller scale of management activity, compared with the other action alternatives, to restore portions of the impacted area. This alternative would focus actions on areas that are unstable and present a high potential of continued degradation of existing ecosystem resources and services. Management activities would be conducted using hand tools to reduce impact on wilderness character. Actions would be conducted to stabilize limited areas of unstable debris deposits resulting from the 2003 breach on slopes and banks. These areas are too steep or unstable to support natural revegetation, and the objective would be to establish a stable slope and suitable plant material that could accelerate revegetation and return of natural stability. In zone 1 B, zone 2 along Lulu Creek, and zone 3 along the Colorado River, areas have been identified where small amounts of debris and sediments would be redistributed to reduce erosion and where stabilization actions would be implemented in areas with very steep slopes. These are areas where vegetation has not reestablished since the breach and that are above the high water line of the active channel and floodplain. Restoration activities in zone 4 would be limited to repair and stabilization of channel headcuts. Restoration actions vary by zone and are described below. Under this alternative, there would be no active management to change the hydrologic conditions, and the National Park Service would instead rely upon natural processes to restore the hydrologic channel stability condition in the stream channels and wetland areas. The conceptual design for this alternative represents selective bank erosion protection measures at stream channel locations that present severe bank collapse and erosion risks. These measures would be designed to allow the channel banks and slopes to erode at natural rates and would not be designed to prevent natural channel bank development. The current channel slope, width, and bed conditions would be relied upon to carry streamflow and snowmelt runoff. Channel characteristics would change in response to these flows. The degree of restoration under alternative B over time in relation to ecological reference conditions is presented schematically and conceptually in figure 2.1. Figures 2.8 though 2.14 depict the areas to be treated within each zone, and table 2.5 provides the size and extent of alterations proposed.

ZONE 1A

Option 1

This option includes the use of a tie-back anchoring system to stabilize the slope in zone 1A as described in Telesto Solutions, Incorporated (2007). Under option 1, the following actions would take place:

- The slope would be smoothed by dragging a weighted chain, or similar device, over the slope face using a bulldozer at the slope crest. This would help blend the over-steepened slopes on the lateral edges of the scar into the surrounding slope and remove unstable rocks on the slope surface, reducing the erosion potential of sharp slope edges.
- The damaged area would be stabilized using soil-nail anchors that consist of long steel rods (about 8 feet long) that would be installed through the unconsolidated fill either by drilling or grouting, or by driving them directly into place. They would be installed through the fill starting from the slope crest and working down the slope.

- Steel mesh would be installed over the slope face and anchored to the soil nails. This would be done to prevent raveling of materials and would extend approximately 50 feet beyond the current limits of the scar.
- Specific surface treatments such as geocell installation or rock mulching may be required in critical locations to control shallow, surficial flow slides and provide erosion protection for the recently placed fill slopes.
- Installing a reinforced earth cap along the ditch road would help maintain surface drainage away from the crest and would reduce raveling of slope face materials. Installing the earth cap would involve partially excavating the uppermost fill along the access road and replacing it with a compacted, geotextile, or geogrid reinforced earth section. Vertically installed micropiles could be used to further stabilize loose-dumped fill beneath the reinforced-earth cap.

The restoration work in zone 1A under option 1 would require two years to complete.

Restoration work would be conducted by contractors under the supervision of an NPS manager.

Option 2

This option would stabilize the slope using rock buttresses and by back-filling the gully to achieve pre-breach slope contours. Under option 2, the following actions would take place:

- A toe buttress constructed at the toe of the existing fill slope would act as a berm for the fill placement. This structure could be constructed from timber cribbing or from rock fill with or without rock bolts depending on the results of the survey and design.
- Compacted fill consisting primarily of silty gravels would be placed on the upslope side of the toe buttress up to the crest of the buttress. This would provide the first horizontal work platform for the placement of foundation anchors (rock bolts and/or soil nails). Slope reinforcing geogrid material could then be attached to these anchors and laid horizontally on top of the compacted work platform. Fill material would be obtained from a commercial source. Fill material would be hauled to the site using the existing ditch access road, or along the bottom of the ditch itself.
- The previous step would then be repeated through placement of a layer of compacted backfill on top of the geogrid material. The actual vertical spacing of the geogrid material would depend on the results of the stability analysis conducted during the design phase. This procedure would then be repeated up to approximately the existing invert level of the ditch.
- Compacted backfill material from the invert level of the ditch would be placed to the existing road level.
- In addition, a growth media cover, up to 2 feet thick, would be placed on the face of the compacted fill. This could be executed as the individual lifts are constructed. This cover would be vegetated as part of the long-term stabilization of the fill with a suitable seed mixture.

The restoration work in zone 1A under option 2 would require two years to complete.

Mechanized equipment expected to be used in the stabilization activities of zone 1A include, but not be limited to, excavators, front end loaders, dump trucks, and water trucks. Some of this equipment would need to be specialized for use in very steep areas. The use of six-wheel articulating haul trucks could minimize impact on roads, including the ditch access road.

Equipment staging and stockpiling of materials before transport to zone 1A would be along the Grand Ditch maintenance road in an area that has been previously disturbed—that is, graveled, cleared, or in a nonvegetated condition. Mechanized equipment would access the project area using the maintenance road.

Restoration work would be conducted by contractors under the supervision of an NPS manager.

The area within 200 horizontal feet of the centerline of the Grand Ditch is not included in the wilderness designation. Therefore, much of the stabilization effort in this zone would not be in the wilderness area of the park. However, some actions taken to stabilize the steep slopes in zone 1A may involve the use of adjacent wilderness areas to access the zone, and actions taken in zone 1A would indirectly affect adjacent wilderness. Actions in zone 1A would therefore be subject to a minimum requirements analysis.

ZONE 1B

The restoration objectives for zone 1B under alternative B would be to stabilize the established gully that was created by the breach.

In the majority of the zone 1B (represented as area A on figure 2.10), exposed surfaces along the banks and in the gully would be revegetated with native vegetation. In areas where sufficient soil exists to allow germination of seed and seedling growth, hand tools would be used to prepare the designated surfaces for receiving seed.

ZONE 2

Under alternative B, the restoration objectives for zone 2 would be to stabilize banks along the channel created by the breach (figure 2.10, area B) and Lulu Creek by seeding and through minor redistribution of debris and sediments. The alluvial fan at the confluence of Lulu Creek and the Colorado River would be left in place. Treatment areas within zone 2 are identified on figures 2.10 and 2.11.

Throughout zone 2, revegetation of exposed surfaces that are conducive to seed plant growth as described for zone 1B would take place in areas above the high water mark. Selected debris and sediment would be removed outside of the channel or reoriented in the channel and along the banks using hand tools to stabilize banks and minimize erosion.

In zone 2 (area E on figures 2.10 and 2.11), some streambank locations are highly susceptible to erosion, and the stream channel is moving laterally in this stretch of Lulu Creek. To reduce erosion and sediment transport downstream, the slopes of the banks along approximately 1,000 linear feet of the stream would be stabilized using appropriately sized cobble and boulders collected from within zone 2. Cobble and boulders would be repositioned along the toes of steep and unstable slopes for bank retention during normal and high streamflows.

At the alluvial fan (represented as area F on figure 2.11), exposed surfaces above the ordinary high water mark would be seeded. Using cobbles and boulders from within zone 2, braids that have formed toward the edges of the fan would be contoured and stabilized to prevent further lateral erosion within the fan. This would occur along approximately 500 linear feet of stream. Streamflow would continue to occur through the fan in the central braids. Some natural redistribution of the debris and sediment within the fan would occur during years of above-average streamflows.

ZONE 3

Within zone 3, the restoration objectives under alternative B would be to stabilize the banks along the Colorado River with vegetation while leaving the debris deposits that resulted from the breach within the zone. Treatment areas within this zone are identified on figures 2.11, 2.12, and 2.13.

Under this alternative, areas outside the active channel would be revegetated with native plant species such as cottonwoods, spruce, lodgepole pine, fir, alder, and willows as dictated by site conditions. Approximately 2 acres within this zone would be revegetated.

ZONE 4

Within zone 4, the restoration objectives under alternative B would be to stabilize exposed surfaces within the Lulu City wetland by revegetating and minor recontouring of unstable areas where headcutting and knickpoints are occurring, as in the photograph. The current channel configuration of the Colorado River would be maintained along the western portion of the wetland or the channels that exist at the time of restoration, and sediment deposits would not be removed. Treatment areas within this zone are identified on figures 2.13 and 2.14.

Example of headcutting in the Lulu City wetland

Within the treatment areas, spot revegetation with native sedge and wetland grass species would be conducted in exposed areas. Hand tools would be used to stabilize erosion prone banks with gravel and cobble collected within zone 4. Existing channelbanks that are relatively stable would not be treated.

In areas where headcuts and knickpoints have formed, the stream grade would be reduced in localized areas using hand tools, and the graded area would be stabilized with limited amounts of gravel and cobbles from within the zone to allow vegetation to recover and provide long-term stabilization. Newly disturbed areas would be revegetated with native sedges or wetland grass species. Whenever possible, sod that was removed during the restoration activity would be reused. In total, approximately 1 acre of wetland habitat would be revegetated under alternative B.

RESTORATION IMPLEMENTATION

Given the limited amount of soil disturbance, there would be no stockpiling of materials. Any material removed for planting would be distributed in the area adjacent to the plantings and contoured using hand tools such as chainsaws, shovels, and rakes to reflect the surrounding topography. A temporary camp for crews would be staged in an upland area near Dutch Creek (figures 2.12 and 2.13, area N).

Vegetation restoration methods would be as described in the "Management Actions Common to All Action Alternatives" section above.

Crews, supplies, and hand tools would be brought into the project area by trucks using the Grand Ditch maintenance road. Additionally, supplies may be delivered to work crews by pack animals. Crews would consist of teams made up of NPS or contractor employees who would work at separate areas concurrently.

It is expected that the actions in zones 1B through 4 under alternative B would take up to two years to complete.

MITIGATION MEASURES AND BEST MANAGEMENT PRACTICES

In addition to those mitigation measures and best management practices identified in the "Actions Common to All Alternatives" section of this chapter, the following additional measures would be taken under alternative B to protect resources.

Measures to Protect Water Quality, Stream Channel Morphology, and Hydrology

- Slope recontoured materials so that the final slope is not steeper than a ratio of 2 horizontal to 1 vertical. A ratio of 3 horizontal to 1 vertical is preferred.
- Work bank materials from the land side or bank of the channel instead of the stream channel to the maximum extent practicable.
- To the greatest extent practicable, conduct restoration activities in Lulu Creek, Colorado River, and the Lulu City wetland during the low-water period of the year to minimize turbidity and suspended sediment impacts.
- Develop and approve a water quality management plan before start of construction.

ALTERNATIVE C – HIGH RESTORATION

This alternative would involve more intensive management actions over large portions of the impacted area. This alternative would focus actions on unstable areas that present a high to moderate potential of continued degradation of existing ecosystem resources and services. Restoration methods would be used to stabilize the 2003 debris deposits along slopes and banks and to lessen the availability of breach debris and sediments to the system over a larger portion of the project area. This alternative would actively restore the hydrologic conditions in large portions of the impacted area by removing sediment from the 2003 breach and additional historical unnatural debris deposits in the Lulu City wetland as needed to restore wetland functions, constructing and enhancing step pools and pool-riffle complexes, and providing addition flood storage along the Colorado River in localized areas. Active measures would be taken to plant and fence willow communities in some locations in zones 3 and 4. This alternative would involve the use of heavy equipment and possibly reusing excavated debris and sediment for restoration and stabilization actions both within and between zones. Channel restoration would achieve stream channels that are more hydrologically and hydraulically stable and provide streambed and channel dynamic stability. The conceptual design for this alternative represents basic hydraulic engineering requirements to ensure that flows are naturally conveyed within the stream channel cross sections in lower Lulu Creek (zone 2), the upper Colorado River (zone 3), and the Colorado River through the Lulu City wetland (zone 4), and that the channels would maintain hydrologic function. The degree of restoration under alternative C over time in relation to ecological reference conditions is presented schematically and conceptually in figure 2.1. Figures 2.15 though 2.19 depict the areas to be treated within each zone, and table 2.5 provides the size and extent of the proposed restoration.

ZONE 1A

Stabilization of the slope within this zone would be accomplished using either option 1 or option 2, as described under alternative B.

ZONE 1B

The restoration objectives for this zone under alternative C would be to stabilize the undercut banks and area within the gully by recontouring and revegetating exposed and disturbed surfaces. Areas to be treated within zone 1B are depicted on figure 2.15.

Recontouring of steep slopes and undercut banks (banks that have a slope that is 1:1 horizontal to vertical ratio or steeper would be conducted throughout the zone (figure 2.15, area A) to achieve slope conditions that are approximately 2:1 or flatter. Approximately 700 linear feet along the gully would be recontoured within zone 1B. Debris removed from the lower portion of the zone could be used as needed for recontouring.

Recontouring would be done using small mechanized equipment such as small tillers, motorized blades, shovels and rakes, compactors, and hand tools to flatten banks and firm the disturbed soil to make it suitable for plant growth. Given the steepness of the area, steep-slope/all-terrain, “walking” excavators would be used to move large pieces of debris and to recontour, regrade, and compact soil.

Approximately 1 acre of exposed surfaces along the sideslopes, in the gully, and areas disturbed by recontouring would be revegetated with native vegetation.

ZONE 2

The restoration objectives for this zone under alternative C would be to stabilize steep slopes by recontouring banks and revegetating exposed surfaces. A series of existing step pools would be enhanced (new step pools might be created, depending on channel conditions at the time restoration begins) using boulders and large woody debris from within the zone to reduce stream velocity and sediment transport. Step-pools would be expected to migrate downstream and reform during periods of high runoff. Braided channels would be filled in, and a single channel configuration established. Portions of the alluvial fan would be removed and converted into a terrace to store and stabilize the 2003 breach sediments. These terraces would be contoured to reflect old glaciated features created during the last ice age and should be unnoticeable in the future. Hydrologic conditions would be restored to reflect pre-breach conditions in most of the zone, with the exception of the area of the alluvial fan. Areas to be treated within zone 2 are depicted on figures 2.15 and 2.16.

Throughout the zone, selected debris and sediment deposits would be removed outside the channel or reoriented in the channel to protect banks and minimize erosion. Areas outside the original channel would be filled with in situ debris and sediment, compacted, and recontoured to reflect the original contours.

In zone 2 where the perennial stream has established to the north of Lulu Creek (figure 2.15, area B), cobbles, boulders, and large woody debris would be repositioned to the toes of steep and unstable slopes to reduce or eliminate further erosion of 2003 debris deposits along approximately 700 linear feet of the main channel. The other braided channels would be filled in with debris and sediment and contoured to maintain stability.

If further comparisons to reference conditions warrant it, then existing step pools along Lulu Creek (figure 2.15, areas C and E) would be enhanced by increasing the height of steps using a combination of cobbles, boulders, and woody materials to reduce stream energy. New step pools would be created as dictated by slope and grade using boulders and large woody material that had been deposited within the zone, as in the photograph.

Example of a step pool sequence

Recontouring of steep streambanks along approximately 1,800 linear feet of Lulu Creek would be conducted to accommodate reestablishment of riparian vegetation and to prevent sloughing of banks under normal flow conditions. Debris and sediment from within zone 2 would be used as needed to accomplish the desired bank slopes. Excess bank deposits would be scattered as needed in adjacent areas to provide suitable growing conditions for native vegetation. In addition, debris deposits along the banks would be protected using cobbles, boulders, and large woody materials along approximately 3,900 linear feet of the channel.

At the alluvial fan (figure 2.16, area F), a single channel with step pools would be established. Debris and sediment within the alluvial fan would be partially removed with the excavation of approximately 1,900 cubic yards of debris. A single channel would be maintained that may be approximately 8 to 16 feet wide and several feet deep, consistent with upstream conditions. The channel would be designed to be geomorphologically stable for the expected range of flow conditions using techniques that would make it indistinguishable from a natural channel. It could accommodate some lateral movement under a wider (e.g., higher) range of flow conditions. The excavated debris and sediment would be used to create terraces in a 0.5-acre upland area adjacent to the stream (figure 2.16, area G). These terraces would be contoured to reflect old glaciated features created during the last ice age and should be unnoticeable in the future. Banks within the single channel alluvial fan would be stabilized with cobbles and boulders to limit erosion of 2003 breach debris. During channel restoration, a temporary bypass channel or pipe may be needed to route streamflow around the channel work areas. These features would be either removed or refilled and stabilized after the channel work was completed.

Recontouring and regrading throughout the zone would be done using small mechanized equipment, as described for zone 1 B.

In the treated area within zone 2, exposed surfaces along the streambanks and areas disturbed by recontouring would be revegetated with native vegetation. The alluvial fan would be revegetated with native vegetation such as lodgepole pine and aspen to accelerate forest recovery in this area. In the newly established terrace area, revegetation with native lodgepole pine, Engelmann spruce, and other upland species would occur. Revegetation activities would occur over approximately 5 acres.

ZONE 3

Within zone 3, the restoration objectives under alternative C are to stabilize the 2003 debris deposits along the banks of the Colorado River and remove selected deposits of debris and sediment from the stream channel and the floodplain. Enhancements to step pools and pool-riffle complexes would also be conducted to restore hydrologic conditions. This alternative would also seek to enhance floodplain and wetland functions to low-lying areas on the east bank immediately upstream from the Lulu City wetland that have been separated from river recharge by accumulations of debris and sediment. Treatment areas within this zone are identified on figures 2.16, 2.17, and 2.18.

In the upstream portion of this zone (figure 2.16, area F), large cobbles, small boulders, and large woody material deposited in the channel would be relocated to stabilize the 2003 debris deposits and enhance step pool development. Pool-riffle complexes would be established in the downstream portion of this zone. These enhancements would take place along approximately 900 feet of the river to manage stream channel erosion and lessen the availability of breach debris and sediment to the system.

To provide additional flood storage in this area, a series of 5- to 10-foot-wide cuts would be made through the sediment berms that have formed along approximately 900 feet of the of the east bank of the river (figure 2.17, area L). The base of the cut would be at least as low as the surface elevation of the wetland. Nearly 300 cubic yards of debris would be removed from this area.

Debris removed during restoration activities would be deposited in terraces in an upland area near Dutch Creek (figures 2.17 and 2.18, area N). The terraces would be contoured to reflect old glaciated features created during the last ice age and should be unnoticeable in the future. They would be revegetated with native plant species to accelerate site stabilization.

Recontouring and regrading throughout the zone would be done using mechanized equipment such as small tillers, motorized blades, shovels and rakes, compactors, and hand tools to flatten banks and compact the disturbed soil. In addition, steep-slope/all-terrain walking excavators would be used to move large pieces of debris, woody materials, and sediment and for recontouring.

Revegetation activities to stabilize exposed surfaces and/or disturbed areas would be as described under alternative B. Riparian species such as willows, cottonwood, and alders would be used to vegetate approximately 2 acres on gravel bars and along the streambank to reduce erosion potential and to replace trees that were lost to the debris flow. Upland species, such as lodgepole and Engelmann spruce seedlings, would be used to vegetate approximately 3 acres in the newly developed terrace area near Dutch Creek to accelerate forest recovery and site stabilization (figures 2.17 and 2.18, area N). Approximately 4,000 feet of browsing exclosure fences would be used to protect newly planted willows from wildlife browsing. These fences would remain in place until the plants reached approximately 8 feet in height and could withstand browsing pressure (assumed to take approximately 15 to 20 years). At that time, the fences would be removed.

ZONE 4

Within zone 4, the restoration objectives under alternative C would remove the 2003 debris, or sediment as necessary (refer to estimates in table 2.6), to restore the wetland and Colorado River functions and conditions. Under this alternative, the flow of the Colorado River would be reestablished through the historical central channel by excavating selected sections of the channel that have been blocked by debris and subsequent sediment deposits. The existing river channel along the western portion of the wetland would be blocked and reconfigured to reflect wetland conditions suitable to the development of tall willow complexes. Exposed surfaces within the wetland would be stabilized by revegetating and by minor recontouring in unstable areas where headcutting and knickpoints are occurring. Treatment areas within this zone are identified on figures 2.18 and 2.19.

Under alternative C, a channel approximately 50 linear feet long would be excavated at the northern end of the wetland (figure 2.18, area O) in a new alignment to connect the current river channel with the historical central channel.

If necessary based on final design specification, at the upstream end of the wetland, a small berm or barrier of approximately 5,000 square feet would be created out of cobbles, boulders, sediment, and debris such as logs excavated from zone 4 to encourage river flow to the new alignment. The berm would be designed, constructed, and anchored so that it resists high-flow erosional forces. This berm would be constructed to blend with existing physical setting, revegetated with trees, shrubs, and grasses so that it would appear as a natural landform.

The existing channel along the western portion of the wetland (see figure 2.18, area P) would be reconfigured to reflect wetland conditions suitable to the development of tall willow complexes that were historically present. Extensive grading of existing wetland areas in the north and central thirds of zone 4 would be required to remove existing debris and sediment deposits and to create the proper elevations and grades to accommodate tall willow development and the desired groundwater to ground surface conditions. Approximately 16,300 cubic yards of debris would be removed from the wetland. Treatment areas within this zone are identified on figures 2.18 and 2.19.

The length of the historical channel (approximately 3, 700 feet) through the center of the wetland would be excavated to allow continuous flow through the channel (figures 2.18 and

2.19, area Q). This would involve excavating approximately 6,600 cubic yards of debris from the channel. Highly erosive areas would be stabilized using gravel, cobbles, and rocks from within this zone to prevent erosion until native vegetation has established. The channel would be designed to be geomorphologically stable for the expected range of flow conditions using techniques that would make it indistinguishable from a natural channel. It would be wide enough to accommodate some lateral movement of the stream under a range of flow conditions.

Debris and sediment removed during restoration activities that was not used in the restoration of flow through the historical central channel would be deposited in an upland area near Dutch Creek (figures 2.18 and 2.19, area N). The material would be contoured to reflect the surrounding topography, and upland vegetation would be established.

Recontouring, bank stabilization, and relocation of debris and sediment throughout the zone would likely be done using mechanized equipment such as small tillers, motorized blades, shovels and rakes, compactors, and hand tools to flatten banks and compact the disturbed soil. Walking excavators, backhoes, and front end loaders may be used to create the connecting channel, excavate debris and sediment from the historical channel, and, if necessary, construct a small berm or barrier to encourage streamflow to the new center channel configuration.

Within the treatment areas identified for zone 4, revegetation using cuttings of tall willow species would be conducted in exposed areas and newly disturbed areas (figures 2.18 and 2.19, areas P, Q, and S). Approximately 20 acres of predominantly sedge and willow wetland habitat would be restored to a tall willow complex under alternative C.

Approximately 13,300 feet of browsing exclosure fences would be used to protect newly planted willows from browsing pressure. These fences would remain in place until the plants reached approximately 8 feet in height and could withstand browsing pressure (assumed to take approximately 15 to 20 years). At that time, the fences would be removed.

RESTORATION IMPLEMENTATION

Mechanized equipment would be flown in using helicopters at the beginning of the project and flown out after project completion. Equipment would be left in the project area over winter. During the restoration activities, equipment and materials used to conduct work in zones 1B and 2 would be staged in the area of the alluvial fan (figure 2.16, area F). Equipment and materials used for zones 3 and 4 would be staged near Dutch Creek (figures 2.17 and 2.18, area N). A temporary facility for crews would also be located in this area. This area is also identified as a suitable location for a helicopter landing.

Mechanized equipment expected to be used in the restoration activities would include, but not be limited to, walking excavators, front end loaders, bulldozers, graders, dump trucks, and water trucks. Some of this equipment would need to be specialized for use in very steep areas and in muddy and highly saturated areas where groundwater is near the surface. Equipment with rubber tracks would be used whenever possible to minimize damage to the ground surface. Heavy equipment used in wetlands would be placed on mats, or other measures would be taken to minimize soil and plant root disturbance and to preserve preconstruction elevations where appropriate.

Restoration of surface water and groundwater hydrology in zone 4 would require phasing excavating and grading activities as early actions so the effectiveness of the measures could be monitored and modified (if necessary) within the construction period of two to three years.

Equipment would be moved through the project area, particularly in zones 1B, 2, and 3, along the disturbed areas adjacent to and in the stream channels. No temporary road would be constructed under this alternative.

Restoration activities beyond those described in "Management Actions Common to All Action Alternatives" would include the possible use of coffer dams or temporary impoundments to divert streamflow or adequately dewater areas to allow restoration actions to take place. Any of these methods would be temporary and would be dismantled and removed after implementation of the restoration activity. These temporary actions may include the mitigation measures identified for this alternative and would conform to best management practices to minimize impacts on water quality, wetlands, and aquatic species.

Restoration activities would be conducted over a two- to three-year period.

MITIGATION MEASURES AND BEST MANAGEMENT PRACTICES

In addition to those mitigation measures and best management practices identified in the "Actions Common to All Alternatives" section of this chapter, the following additional measures would be taken under alternative C to protect resources.

Measures to Protect Water Quality, Stream Channel Morphology, Hydrology, and Wildlife

- Create a vegetated buffer zone of 100 feet between the edge of the debris storage area and the nearest surface water body to minimize eroded material entering the water body.
- Restrict all construction equipment and activities in zone 2 (Lulu Creek) to the area disturbed by the 2003 breach.
- While installing or improving step-pools in Lulu Creek, use temporary, large-diameter pipes to convey the stream around the construction site.
- During the new channel construction phase, minimize downstream turbidity and channel sedimentation in the Colorado River by keeping river flow in its present natural channel until the new channel is completed, stable, and capable of accommodating flows.
- Maintain earthen and/or rock plugs and temporary flow by-pass structures (if needed) at one or both ends (as appropriate) of the new channel during construction to prevent contaminated water and loose sediments from entering the Colorado River.
- Discharge water resulting from groundwater and surface water dewatering to temporary sediment retention ponds or holding areas to reduce suspended sediments to permitted limits before being released to surface waters.
- In the Lulu City wetland, use excavation equipment designed to work in wet conditions (for example, low tire pressure, low impact earthmoving equipment, or working from mats) and to minimize damage to adjacent wetlands.
- Cross streams and wetlands with project-related construction vehicles only at established and marked crossing points.
- Locate stream crossings required during construction operations, as much as possible, in areas with minimum streambank heights, stable and dry bank slopes, and low streambed gradients.

- Return all stream crossing points to their preconstruction contours to the extent practicable, and the crossing banks would be reseeded or replanted with native species immediately after project-related construction.
- Place temporary erosion control measures after each day's construction and during the day when threatening thundershowers are likely. Immediately after runoff of sufficient magnitude, inspect mitigating measures for adequacy of performance, for whether maintenance is required, and for structural adequacy. Deficiencies in performance would be corrected as soon as practicable.
- Timing is a critical factor in erosion and sedimentation control on construction sites. Install temporary sediment traps, basins, or ponds when construction begins. For each step of construction, install control measures to protect exposed areas, either before actual construction work begins or concurrently with the start of construction.
- Maintain instream flows throughout the entire channel construction, diversion, and restoration operations.
- During construction in the river, maintain an open passage for fish passage around the construction site at all times.
- To the extent possible, time all channel construction and diversion activities to coincide with periods of low streamflow.
- Prior to conducting construction or dewatering activities in the Colorado River, the Lulu City wetland, or other waters or channels that support trout populations, salvage as many trout as reasonably possible and relocate them to a different portion of the river or watershed that would not be affected by restoration activities.
- Fish habitat components such as logs, stumps, and/or large boulders may be required as part of the bank protection project to mitigate project impacts. Install these fish habitat components according to an approved design.
- Where temporary plugs or other by-pass structures are left in place during the period of approximately September 30 to June 15, they would be designed to maintain structural integrity during peak flows with consideration of the debris loading likely to be encountered.
- Before delivery to the project site, decontaminate equipment that would have contact with stream and wetland areas following current park protocols prior to working on the site.

ALTERNATIVE D – NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

This alternative would emphasize the removal of large debris deposits in the alluvial fan area of zone 2 and in the Lulu City wetland, zone 4. Actions would be conducted to stabilize limited areas of unstable 2003 debris deposits along slopes and banks. In zones 1B, 2, and 3, stabilization actions would be implemented in areas with steep slopes, where vegetation has not reestablished since the 2003 ditch breach occurred, and outside the channel and floodplain that are not exposed to high flows. Actions, however, would be taken to remove selected debris and sediment deposits to enhance hydrologic conditions and to remove debris sources that could be eroded and transported downstream as sediment. The debris deposited in the alluvial fan could be removed, and sediment could be removed in localized areas along the Colorado River to reconnect the river with some previously blocked floodplain locations. Sediment from the 2003 breach and additional historical unnatural debris deposits would be removed as needed to restore wetland functions in the Lulu City wetland. Hydrology through the Lulu City wetland would be restored in the historical central channel through removal of large, localized deposits of debris and sediment, relying on the historical channel to transport river flow. Small-scale motorized equipment may be employed for stabilization and revegetation activities, while larger equipment may be employed for excavation of large debris deposits such as in the Lulu City wetland. Channel restoration would achieve stream channels that are more hydrologically and hydraulically stable and provide streambed and channel dynamic stability. The conceptual design for this alternative represents basic hydraulic engineering requirements to ensure that flows are naturally conveyed within the stream channel cross-sections and that the channels would maintain hydrologic function, while accommodating the natural range of overbank flooding of adjacent wetlands. The degree of restoration under alternative D over time in relation to ecological reference conditions is presented schematically and conceptually in figure 2.1. Figures 2.20 though 2.24 depict the areas to be treated within each zone, and table 2.5 provides the size and extent of the restoration proposed.

ZONE 1A

Stabilization of the slope within this zone could be accomplished using option 1, as described under alternative B.

ZONE 1B

The restoration objectives for zone 1B under alternative D would be to stabilize the established gully that was created as a result of the breach.

In the majority of the zone 1B (represented as area A on figure 2.20), exposed surfaces along the banks and in the gully may be revegetated with native plant species. In areas where sufficient soil exist to allow propagation of seed, hand tools would be used to prepare the designated surfaces for receiving seed.

Revegetation and spot stabilization may be done using small mechanized equipment such as small tillers, motorized blades, shovels and rakes, compactors, and hand tools to flatten banks and compact the disturbed soil.

Walking excavator

A walking excavator may be used to reshape and stabilize more difficult slopes.

ZONE 2

Under alternative D, the restoration objectives for zone 2 would be to stabilize banks along the channel created by the breach (figure 2.20, area B) and Lulu Creek by revegetating and through minor redistribution of debris, except at the large alluvial fan at the south end of the zone.

The alluvial fan at the confluence of Lulu Creek and the Colorado River would be largely removed, and the creek would flow through a single stable channel instead of a series of braided channels. The portion of the alluvial fan left in place would be protected from future erosion by high streamflows. Treatment areas within zone 2 are identified on figures 2.20 and 2.21.

Throughout zone 2, revegetation of exposed surfaces conducive to plant establishment may take place in areas above the high water mark. Selected debris may be removed outside of the channel or reoriented in the channel and along the banks using hand tools to stabilize banks and minimize erosion. The alluvial fan would be revegetated with native vegetation such as lodgepole pine and aspen to accelerate forest recovery in this area.

In zone 2 (area E on figures 2.20 and 2.21), the streambanks are easily eroded, and the stream channel is moving laterally in this stretch of Lulu Creek. To reduce erosion of 2003 breach debris, the slopes of the banks along approximately 3,100 linear feet of the stream could be stabilized using appropriately sized cobble and boulders collected from within zone 2.

In the area of the alluvial fan (figure 2.21, area F), Lulu Creek would be restored to reflect pre-breach conditions. The 2003 debris would be removed and a single stream channel with step pools may be established. Approximately 6,600 cubic yards of debris from the alluvial fan would be excavated to remove the primary source of constant sediment erosion and transport downstream into zones 3 and 4. A single channel would be maintained that may be approximately 8 to 16 feet wide and several feet deep, consistent with upstream conditions. The channel restoration would be designed to allow the stream to reach a dynamic equilibrium. The channel would be geomorphologically stable for the expected range of flow conditions using techniques that would make it indistinguishable from a natural channel. It would be wide enough to accommodate some lateral movement of the stream under a range of flow conditions. If necessary, based on comparison to reference stream conditions, new step pools may be created as dictated by slope and grade using boulders and large woody debris that had been deposited within the zone. This design could help prevent debris and sediment deposits from the 2003 breach from eroding during high runoff periods.

The excavated debris would be used to create terraces in a 0.5-acre upland area northeast of and well-removed from the stream (figure 2.21, area G). These terraces would be contoured to reflect old glaciated features created during the last ice age and should be unnoticeable in the future.

Revegetation and bank stabilization may be done using small mechanized equipment such as small tillers, motorized blades, shovels and rakes, compactors, and hand tools to flatten banks and compact the disturbed soil. Removal of the debris in the alluvial fan and recontouring of that area may require larger equipment such as front-end loaders, excavators, and backhoes.

In the treated area within zone 2, exposed surfaces along the streambanks may be revegetated with native plant species. In the restored alluvial fan area and in the newly established terrace area, revegetating with native vegetation such as lodgepole pine, Engelmann spruce, and other upland species would occur.

Approximately 5,600 feet of browsing exclosure fences may be used to protect newly planted or seeded riparian areas from browsing pressure in the lower portion of zone 2 and the upper portion of zone 3 (figure 2.21, area F). These exclosures could remain in place until the plants reached approximately 8 feet in height and could withstand browsing pressure (assumed to take approximately 15 to 20 years). At that time, the exclosures would be removed.

ZONE 3

Within zone 3, the restoration objectives under alternative D would be to remove the debris from the alluvial fan in the upper portion of the zone and to stabilize the 2003 debris deposits along the banks of the Colorado River downstream with native vegetation. This alternative may seek to enhance floodplain and wetland functions to low-lying areas on the east bank immediately upstream from the Lulu City wetland that have been separated from river recharge by accumulations of debris and sediment. Treatment areas within this zone are identified on figures 2.21, 2.22, and 2.23.

In the upstream portion of this zone (figure 2.21, area F), the debris within the alluvial fan would be removed and a single channel with step-pools may be established as described in zone 2.

To provide additional flood storage in this area, a series of 5- to 10-foot-wide cuts may be made through the sediment berms that have formed along approximately 900 feet of the of the east bank of the river (figure 2.22, area L). The base of the cut would be at least as low as the surface elevation of the wetland. Approximately 300 cubic yards of debris would be removed from this area.

Debris and sediment removed during restoration activities would be deposited in terraces in an upland area near Dutch Creek (figures 2.22 and 2.23, area N). The terraces would be contoured to mimic old glaciated features created during the last ice age and should be unnoticeable in the future. They would be revegetated with native vegetation, including trees, to accelerate site stabilization.

Spot stabilization and revegetation throughout the zone could likely be done using mechanized equipment such as small tillers, motorized blades, shovels and rakes, compactors, and hand tools to flatten banks and compact the disturbed soil.

Under this alternative, areas below the alluvial fan deposit and outside the active channel would be revegetated with native vegetation as dictated by site conditions. Approximately 2 acres within this zone would be revegetated. Approximately 3 acres of native upland species such as lodgepole and Engelmann spruce would be planted on the newly developed terrace area near Dutch Creek (figures 2.22 and 2.23, area N).

ZONE 4

Within zone 4, the restoration objectives under alternative D are to remove the 2003 debris or sediment deposits as necessary to restore wetland and Colorado River functions and conditions. Historically, the Colorado River meandered to the west at the northern end of the Lulu City wetland and then flowed south and east through the center of the wetland. However, as a result of debris accumulations and bedload shifts, this channel has been cut off from the river, resulting in a remnant meander (see figure 2.23, area O). This area currently appears as a shallow, linear depression that is mostly filled in with sediment deposited by past river high-flow events. It is vegetated with a mix of sedges, rushes, hydric grasses, small lodgepole pine, willow, and other tree and shrub species. Surface depressions contain shallow water during spring and early summer months.

Under this alternative, the flow of the Colorado River, in area O would be established in the previously disturbed area somewhere between the western bank of the remnant meander channel to the eastern bank of the currently active channel. The exact location would depend on the sustainability of the new configuration and would be determined later based on further input from subject matter experts and design finalization. Regardless of the channel location, the Colorado River would enter and pass through the wetland through the historical central channel. At a minimum, the actions described under alternative C could be conducted to reconnect the river to the historical channel. At a maximum, it is estimated that no more than 5,300 cubic yards of debris and sediment could be needed to accomplish this (figure 2.23, area O).

The existing channel along the western portion of the wetland (see figure 2.23, area P) would be reconfigured to reflect wetland conditions suitable to the development of tall willow complexes that were historically present. Extensive grading of existing wetland areas in the north and central thirds of zone 4 would be required to remove existing debris and sediment deposits and to create the proper elevations and grades to accommodate tall willow development and the desired groundwater to ground surface conditions. Approximately 12,000 cubic yards of debris could be removed from the wetland. Treatment areas within this zone are identified on figures 2.23 and 2.24.

To facilitate downstream flow through the historical central channel, two sections within the channel would be excavated along approximately 500 feet of the channel (figures 2.23 and 2.24, area Q). This may involve excavating approximately 900 cubic yards of debris and sediment from the channel. The channel would be designed to be geomorphologically stable for the expected range of flow conditions, using techniques that would make it indistinguishable from a natural channel. It would be wide enough to accommodate some lateral movement of the stream under a range of flow conditions. Highly erosive areas may be stabilized using gravel, cobbles, and rocks from within this zone to prevent erosion until native vegetation has established.

The southern portion of the existing western river channel would be filled in with approximately 1,000 cubic yards of materials suitable to establish conditions for a tall willow complex and to minimize draining newly restored upstream or upgradient wetland areas (figure 2.24, area S). Post-restoration surface contours of the filled channel would be restored to match the surface elevation on either side of the channel.

Debris and sediment removed during restoration activities that was not used in the restoration of flow through the historical central channel would be deposited in an upland area near Dutch Creek (figures 2.22 and 2.23, area N). The material would be contoured to reflect the surrounding topography, and upland vegetation would be established. Most of the recontouring and excavation work completed in this zone may likely be accomplished with large earth-moving equipment. Walking excavators, backhoes, and front end loaders may be used to create the connecting channel and to excavate debris and sediment from the wetlands and the historical channel. Temporary channels or bypass pipes may be required to reroute Colorado River flows during work to stabilize weak sections of the channel or to excavate the old river meander. Temporary turbidity and other water quality protection measures may require restoration and maintenance in zone 4 to minimize downstream effects.

Within the treatment areas identified for zone 4, revegetation using cuttings of tall willow species would be conducted in graded and newly disturbed areas (figures 2.23 and 2.24, areas P, Q, and S). Along the historical central river channel, the area would be revegetated with willows and sedges (figures 2.23 and 2.24, area Q). Approximately 6 acres of predominantly sedge and willow wetland habitat could be converted to a tall willow complex under alternative D.

Approximately 7,700 feet of browsing exclosure fences may be used to protect newly planted willows from browsing pressure. These fences would remain in place until the plants reached approximately 8 feet in height and could withstand browsing pressure (assumed to take approximately 15 to 20 years). At that time, the fences would be removed.

RESTORATION IMPLEMENTATION

Mechanized equipment would be flown in using helicopters at the beginning of the project and flown out after project completion. Equipment may be left in the project area over winter. During the restoration activities, equipment and materials used to conduct work in zones 1B and 2 may be staged in the area of the alluvial fan (figure 2.21, area F). Equipment and materials used for zones 3 and 4 may be staged near Dutch Creek (figures 2.22 and 2.23, area N). A temporary facility for crews may also be located in this area. This area is also identified as a suitable location for a helicopter landing.

Equipment may be moved through the project area, particularly in zones 1B, 2, and 3, along the disturbed areas adjacent to and in the stream channels. No temporary road would be constructed under this alternative.

Restoration of surface water and groundwater hydrology in zone 4 would require phasing excavating and grading activities as early actions so the effectiveness of the measures could be monitored and modified (if necessary) within the construction period of three years.

Restoration activities beyond those described in "Management Actions Common to All Action Alternatives" may include the possibility of dams or temporary impoundments to divert streamflow or adequately dewater areas to allow restoration actions to take place. Any of these methods would be temporary and would be dismantled and removed after implementation of the restoration activity. These temporary actions may include the mitigation measures identified for this alternative and would conform to best management practices to minimize impacts on water quality, wetlands, and aquatic species.

Large-scale restoration activities to remove debris deposits in the alluvial fan and to restore floodplain and wetland conditions may be conducted by contractors or park staff. Smaller-scale restoration activities in zones 1B and 2 may be done by NPS employees or contractors. Restoration activities may be conducted over a two- to three-year period.

MITIGATION MEASURES AND BEST MANAGEMENT PRACTICES

In addition to those mitigation measures and best management practices identified in the "Actions Common to All Alternatives" section of this chapter, the following additional measures would be taken under alternative D to protect resources.

Measures to Protect Water Quality, Stream Channel Morphology, Hydrology, and Wildlife

- The year before construction activities start, the National Park Service will complete a breeding bird survey, by a qualified biologist, in the proposed work areas to survey for endangered, threatened, and candidate species listed on the unit-specific federal endangered and threatened species list and also for species listed on the park's state endangered, threatened, and species of concern list. If any of these birds are noted in the project area a determination on how to best protect them when construction starts the following year will be completed. During construction, it may be necessary to implement appropriate impact mitigation measures, such as a protective buffer zone around a nesting pair of birds or temporarily rescheduling activities.

- Create a vegetated buffer zone of 100 feet between the edge of the debris storage area and the nearest surface water body to minimize eroded material entering the water body.
- Restrict all construction equipment and activities in the area of the alluvial fan in the lower portion of zone 2 (Lulu Creek) and upper portion of zone 3 (Colorado River) to the area disturbed by the 2003 breach.
- While installing or improving step-pools in Lulu Creek and the Colorado River in the area of the alluvial fan, use temporary, large-diameter pipes to convey the stream around the construction site.
- Discharge water resulting from groundwater and surface water dewatering will be diverted into temporary sediment retention ponds or holding areas to reduce suspended sediments to permitted limits before releasing to surface waters.
- In the Lulu City wetland, use excavation equipment designed to work in wet conditions (e.g., low tire pressure, low impact earthmoving equipment, or working from mats) and to minimize damage to adjacent wetlands.
- Cross streams and wetlands with project-related construction vehicles only at established and marked crossing points.
- Locate stream crossings required during construction operations, as much as possible, in areas with minimum streambank heights, stable and dry bank slopes, and low streambed gradients.
- To the extent practicable, ensure that any fill placed below the ordinary high water line of wetlands and streams is clean and free of fine materials. Return all stream crossing points to their preconstruction contours to the extent practicable, and reseed and replant the crossing banks with native species immediately after project-related construction.
- Implement temporary erosion control measures after each day's construction and during the day when threatening thundershowers are likely. Immediately after runoff of sufficient magnitude, inspect mitigating measures for adequacy of performance, for whether maintenance is required, and for structural adequacy. Correct deficiencies in performance as soon as practicable.
- Timing is a critical factor in erosion and sedimentation control on construction sites. Install temporary sediment traps, basins, or ponds prior to construction beginning. For each step of construction, install control measures to protect exposed areas, either before actual construction work begins or concurrently with the start of construction.
- During construction in the river, maintain an open channel in the Colorado River for fish passage around the construction site at all times.
- Maintain instream flows throughout the entire channel construction, diversion, and restoration operations.

- During the new channel construction phase, minimize downstream turbidity and channel sedimentation in the Colorado River by keeping river flow in its present natural channel until the new channel is completed, stable, and capable of accommodating flows.
- Maintain earthen and/or rock plugs and temporary flow by-pass structures (if needed) at one or both ends (as appropriate) of the new channel during construction to prevent contaminated water and loose sediments from entering the Colorado River.
- To the extent possible, time all channel construction and diversion activities to coincide with periods of low streamflow.
- Prior to conducting construction or dewatering activities in the Colorado River, the Lulu City wetland, or other waters or channels that support trout populations, salvage as many trout as reasonably possible and relocate them to a different portion of the river or watershed that would not be affected by restoration activities.
- Install fish habitat components such as logs, stumps, and/or large boulders as part of the bank protection project to mitigate project impacts. These fish habitat components would be installed according to an approved design.
- Where temporary plugs or by-pass structures are left in place during the period of approximately September 30 to June 15, they would be designed to maintain structural integrity during peak flows with consideration of the debris loading likely to be encountered.
- Before delivery to the project site, decontaminate equipment that would have contact with stream and wetland areas, following current park protocols prior to working on the site or mobilizing between sites.

ALTERNATIVE E – MAXIMUM RESTORATION

This alternative would involve extensive management activity and use of motorized equipment over large portions of the impacted area to restore the project area to reflect both pre-breach and desired historical conditions. Extensive recontouring and stabilization of 2003 debris deposits along banks and slopes would be conducted to approximate pre-breach contours and to reduce transport of sediments over a larger portion of the impacted area. Extensive changes would be made to both the existing and historical Colorado River channels to route the river to its historical alignment through the center of the Lulu City wetland. This alternative would actively restore the hydrologic conditions by removing debris deposits resulting from the 2003 breach and additional historical unnatural debris deposits. Debris would be reused in the restoration and stabilization actions both within and between zones. Channel restoration would achieve a stream channel that is hydrologically and hydraulically stable and provides streambed and channel dynamic stability. The conceptual design for this alternative represents basic hydraulic engineering requirements to ensure that flows are naturally conveyed within the stream channel cross sections, while accommodating the natural range of overbank flooding of adjacent areas, and that the channels would maintain hydrologic function, while accommodating the natural range of overbank flooding of adjacent areas. This alternative would involve extensive use of heavy mechanized equipment throughout the impacted area. The degree of restoration under alternative E over time in relation to ecological reference conditions is presented schematically and conceptually in figure 2.1. Figures 2.25 though 2.29 depict the areas to be treated within each zone, and table 2.5 provides the size and extent of the restoration proposed.

ZONE 1A

Stabilization of the slope within this zone would be accomplished using either option 1 or option 2, as described under alternative B.

ZONE 1B

The restoration objectives for this zone under alternative E are to stabilize the undercut banks, fill and contour the gully to approximate pre-breach condition, and revegetate exposed and disturbed surfaces. Areas disturbed by recontouring would be revegetated with native vegetation, including lodgepole pine, to help accelerate forest recovery. Areas to be treated within zone 1B are depicted on figure 2.25.

Recontouring of steep slopes and undercut banks would achieve slope conditions that are approximately 2 to 1 or flatter. Debris and sediment resulting from the restoration of the slopes and removal from zone 2 would be used to fill in the gully, and the area would be contoured to reflect pre-breach conditions.

Recontouring would be done using small mechanized equipment such as small tillers, motorized blades, shovels and rakes, compactors, and hand tools to flatten banks and compact the disturbed soil.

Approximately 1 acre of exposed surfaces along the sideslopes, in the gully, and in areas disturbed by recontouring would be revegetated.

ZONE 2

The restoration objectives for this zone under alternative E are to restore the Lulu Creek channel and banks to pre-breach conditions. Braided channels at the north and south ends of the zone would be filled in, stabilized, recontoured, and revegetated with native vegetation to prevent the erosion and transport of sediment downstream. A single channel configuration would be established with a width reflective of reference channel and slope conditions. Steep slopes would be stabilized by recontouring the banks and by revegetating exposed surfaces. A series of new step pools may be created, depending on future channel conditions at the time design work begins, and/or existing step pools would be enhanced using boulders and large woody material that had been deposited within the zone to reduce stream velocity and sediment transport. The debris within the alluvial fan at the south end of the zone would be completely removed or relocated to an adjacent upland area. Hydrologic conditions would be restored to reflect pre-breach conditions, including the area of the alluvial fan. Areas to be treated within zone 2 are depicted on figures 2.25 and 2.26.

In the north end of zone 2 where the perennial stream has established to the north of the Lulu Creek confluence with the eroded gully (figure 2.25, area B), cobbles, boulders, and large woody material would be repositioned to the toes of steep and unstable slopes to create an erosion-resistant foundation for bank retention along approximately 200 linear feet of the main channel. The other braided channels would be filled in with debris and sediment and contoured to maintain stability.

If further comparisons to reference streams warrant it, along Lulu Creek (figures 2.25 and 2.26, areas C and E) the existing step pools would be enhanced by increasing the height of steps using a combination of cobbles, boulders, and woody material to reduce stream energy. New step pools may be created as dictated by slope and grade conditions at the time restoration work is implemented. Step pools would be developed using boulders and large woody materials that had been deposited within the zone.

Recontouring of the steep streambanks along approximately 2,300 linear feet of Lulu Creek would be conducted to accommodate reestablishment of riparian vegetation and to prevent sloughing of banks under normal flow conditions; approximately 70% of the total length of the creek channel would be affected. Boulders and large woody materials would be reoriented or installed along the banks and in the channel to fill in and stabilize areas that were scoured following the breach. The resulting width of the channel would range from 8 to 16 feet. Debris removed from the alluvial fan in this zone could be used to facilitate this restoration. In addition, debris deposits along the banks would be stabilized using cobbles, boulders, and large woody materials along approximately 3,900 linear feet of the channel.

In the area of the alluvial fan (figure 2.26, area F), Lulu Creek would be restored to reflect a single channel capable of accommodating high spring runoff volumes. Step pools would be established and enhanced as appropriate to reduce stream energy. Approximately 6,600 cubic yards of debris from the alluvial fan would be excavated to remove the primary source of constant debris erosion and transport downstream as sediment into zones 3 and 4. A single channel would be maintained that may be approximately 8 to 16 feet wide and several feet deep, consistent with upstream conditions. The channel would be geomorphologically stable for the expected range of flow conditions using techniques that would make it indistinguishable from a natural channel. It also could accommodate some lateral movement under a wider (e.g., higher) range of flow conditions. The excavated material would be used to create a terrace in a 0.5-acre upland area east of and well removed from the stream (figure 2.26, area G). Excess material could also be deposited in upland areas in zone 3 (figures 2.26, 2.27, and 2.28, areas I and N). These terraces would be contoured to reflect old glaciated features created during the last ice age and should be unnoticeable in the future. Banks along the channel would be stabilized with cobbles and boulders to prevent erosion of 2003 debris deposits.

Recontouring and regrading throughout the zone would be done primarily using mechanized equipment such as steep-slope/all-terrain walking excavators to move large boulders, debris and sediment deposits, and pieces of woody material, and for recontouring. Temporary channels or pipes across the ground surface may be required to route water away from channel work areas.

In the treated area within zone 2, exposed surfaces along the streambanks and areas disturbed by recontouring would be revegetated with native vegetation, including extensive use of tree seedlings, to restore forest conditions more rapidly. The restored areas along the stream channel, in adjacent upland areas, and in the newly established terrace area would receive extensive native plant revegetation efforts, including species such as lodgepole pine, Engelmann spruce, and other upland tree species.

Approximately 5,600 feet of browsing exclosure fences would be used to protect newly planted or seeded riparian areas from browsing pressure in the lower portion of zone 2 and the upper portion of zone 3 (figure 2.26, area F). These fences would remain in place until the plants reached approximately 8 feet in height and could withstand browsing pressure (assumed to take approximately 15 to 20 years). At that time, the fences would be removed.

ZONE 3

Within zone 3, the restoration objectives under alternative E are to remove historical (i.e., pre-2003 breach) unnatural debris deposits and to restore some floodplain surface and groundwater connectivity along portions of the Colorado River. Debris deposits along the banks of the Colorado River would be stabilized, and selected deposits of debris would be removed from the stream channel and the floodplain. Enhancements to step pools and pool-riffle complexes would also be conducted to restore hydrologic conditions. This alternative would also seek to restore floodplain and wetland functions to low-lying areas on the east bank immediately upstream from the Lulu City wetland that have been separated from river recharge by accumulations of debris and sediment. Treatment areas within this zone are identified on figures 2.26, 2.27, and 2.28.

In the upstream portion of this zone (figure 2.26, area F), the debris within the alluvial fan would be removed and a single channel with step-pools would be established as described in zone 2. Large cobbles, small boulders, and large woody material deposited in the channel would be relocated to stabilize banks and to enhance step pool development along approximately 1,600 feet of the river to manage stream channel erosion and lessen the availability of breach debris and sediments to the system. Lateral movement of the river channel would be accommodated to maintain overall channel stability. Pool-riffle complexes would be restored or created in the southern portion of this zone where the stream gradient allows.

To provide additional flood storage in this area, nearly 1,000 cubic yards of sediment along 900 feet of the east bank of the Colorado River would be excavated (figure 2.27, area L).

Debris and sediment removed during restoration activities would be deposited in terraces in an upland area near Dutch Creek (figures 2.27 and 2.28, area N). These terraces would be contoured to reflect old glaciated features created during the last ice age and should be unnoticeable in the future. They would be revegetated with native vegetation, including trees, to accelerate site stabilization.

Recontouring and regrading throughout the zone would likely be done using mechanized equipment such as small tillers, motorized blades, shovels and rakes, compactors, and hand tools to flatten banks and compact the disturbed soil. In addition, steep-slope/all-terrain excavators and haul trucks may be used to move boulders, large debris and sediment deposits, and large pieces of woody material and for recontouring.

Revegetation activities to stabilize exposed and/or disturbed areas would be as described under alternative B. Approximately 2 acres along the streambank would be revegetated with riparian species such as willows, cottonwood, and alders to reduce erosion potential. Over approximately 4.5 acres, upland species such as lodgepole and Engelmann spruce would be used to revegetate newly developed terrace areas west of the river where debris has been deposited (figures 2.26, 2.27, and 2.28, areas I and N). Approximately 4,000 feet of browsing exclosure fences would be used to protect newly planted willows from wildlife browsing. These fences would remain in place until the plants reached approximately 8 feet in height and could withstand browsing pressure (assumed to take approximately 15 to 20 years). At that time, the fences would be removed.

ZONE 4

Within zone 4, the restoration objectives under alternative E are to improve wetland function by removing the 2003 debris and other unnatural sediment deposits and by locating the Colorado River to the center of zone 4. Under this alternative, the flow of the Colorado River would be reestablished through the historical central channel. Most of the historical channel would be reconstructed to ensure a dynamic channel capable of accommodating future flows. Extensive surface grading west of the central river channel would encourage surface water and groundwater flows toward the central channel and would maintain river channel stability. The existing channel along the western portion of the wetland would be excavated as part of the debris and sediment removal actions. Surface elevations and grades would be reconfigured to create wetland conditions suitable to the development of tall willow complexes. Exposed surfaces outside this area within the wetland would be stabilized using sedges, wetland grasses, and tall willow vegetation. Treatment areas within this zone are identified on figures 2.28 and 2.29.

Under this alternative, the flow of the Colorado River in area O would be established in the previously disturbed area somewhere between the western bank of the remnant meander channel to the eastern bank of the currently active channel. The exact location would depend on the sustainability of the new configuration and would be determined later based on further input from subject matter experts and design finalization. Regardless of the channel location, the Colorado River would enter and pass through the wetland through the historical central channel. At a minimum, the actions described under alternative C could be conducted to reconnect the river to the historical channel. At a maximum, it is estimated that no more than 5,300 cubic yards of debris and sediment would be needed to accomplish this (figure 2.28, area O).

The existing channel along the western portion of the wetland (figure 2.23, area P) would be reconfigured to reflect wetland conditions suitable to the development of tall willow complexes that were historically present. Extensive grading of existing wetland areas in the north and central thirds of zone 4 would be required to remove debris and sediment that resulted from the 2003 breach of the Grand Ditch and additional historical unnatural debris deposits and to create the proper elevations and grades to accommodate tall willow development and the desired groundwater to ground surface conditions. Approximately 69,600 cubic yards of debris would be removed from the wetland (figures 2.28 and 2.29, areas P and Q). Approximately 3,600 cubic yards of debris and sediment would also be excavated from 1 acre of the wetland to reestablish a west-side fen that was historically present (figure 2.29, area T). The length of the historical channel (approximately 3,700 feet) through the center of the wetland would be excavated to allow continuous flow through the channel (figures 2.28 and 2.29, area Q). This would involve excavating approximately 6,100 cubic yards of debris from the channel. The channel would be designed to be geomorphologically stable for the expected range of flow conditions using techniques that would make it indistinguishable from a natural channel. It would be wide enough to accommodate some lateral movement of the stream under a range of flow conditions. Highly erosive areas would be stabilized using gravel, cobbles, and rock from within this zone to prevent erosion until native vegetation has established.

The southern portion of the existing west-side river channel would be filled in with approximately 1,000 cubic yards of materials suitable to establish conditions for a tall willow complex and to minimize draining newly restored upstream or upgradient wetland areas (figure 2.29, area S).

Material removed during restoration activities would be deposited in upland areas in zone 3 (figures 2.27 and 2.28, areas I and N) and contoured to reflect the surrounding topography. The area would be revegetated with upland native vegetation.

Most of the recontouring and excavation work completed in this zone would be accomplished with large earth-moving equipment. Walking excavators, backhoes, and front end loaders would be used to create the connecting channel, excavate debris and sediment from the wetlands and the historical channel, and construct a berm or barrier to keep flow in the new center channel configuration. Temporary channels or bypass pipes may be required to reroute Colorado River flows during work to stabilize weak sections of the channel or to excavate the old river meander. Temporary turbidity and other water-quality-protection measures would require restoration and maintenance in zone 4 to minimize downstream effects.

Within the treatment areas identified for zone 4, revegetation using cuttings of tall willow species would be planted in graded and newly disturbed areas (figure 2.28 and 2.29, areas P, Q, and S). Approximately 21 acres of predominantly sedge-willow wetland habitat would be restored to a tall willow complex under alternative E.

Approximately 15,100 feet of browsing exclosure fences would be used to protect newly planted willows from browsing pressure. These fences would remain in place until the plants reached approximately 8 feet in height and could withstand browsing pressure (assumed to take approximately 15 to 20 years). At that time, the fences would be removed.

RESTORATION IMPLEMENTATION

Mechanized equipment would be flown in using helicopters at the beginning of the project and flown out after project completion. Equipment would be left in the project area over winter. During restoration activities, equipment and materials used to conduct work would be staged in the area of the alluvial fan (figure 2.26, area F) and in an upland area along the western bank of the Colorado River and near Dutch Creek (figures 2.27 and 2.28, areas I and N). A temporary facility for crews would also be located in this area in the area of Dutch Creek, as would a helicopter landing area.

Mechanized equipment expected to be used in the restoration activities would include, but not be limited to, walking excavators, front end loaders, bulldozers, graders, dump trucks, and water trucks. Some of this equipment would need to be specialized for use in very steep areas and in muddy and highly saturated areas where groundwater is near the surface.

Equipment with rubber tracks would be used whenever possible to minimize damage to the ground surface. Heavy equipment used in wetlands would be placed on mats, or other measures would be taken to minimize soil and plant root disturbance and to preserve preconstruction elevations where appropriate.

Equipment would be moved through the project area using the disturbed areas adjacent to the stream channels. Due to the large amount of material to be moved within and between zones, a temporary access and mechanized equipment haul road approximately 0.5 mile (2,900 feet) long and 40 feet wide would be required to move excavated material from the wetland area to a permanent upland material disposal area (figures 2.26, 2.27, and 2.28). The haul road would be removed after restoration and recontoured. Both the disposal area and the former haul road would be planted with shrubs or trees to blend with the existing landscape. Approximately 2.7 acres would be affected by these features.

Restoration of surface water and groundwater hydrology in zone 4 would require phasing excavating and grading activities as early actions so the effectiveness of the measures could be monitored and modified (if necessary) within the construction period of up to three years. Restoration activities beyond those described in "Management Actions Common to All Action Alternatives" may include the use of a groundwater dewatering system that would be needed to allow for debris and sediment excavation and removal from this zone. This system would be temporary and would be removed after completion of the restoration activity. Temporary actions performed under this alternative would include the mitigation measures and would conform to best management practices to minimize impacts on water quality, wetlands, and aquatic species.

Restoration activities would be conducted over a two- to three-year period.

MITIGATION MEASURES AND BEST MANAGEMENT PRACTICES

Mitigation measures and best management practices identified under alternatives C and D would also be employed under alternative E. The following additional measures and practices would be implemented under alternative E.

Measures to Protect Water Quality, Stream Channel Morphology, and Hydrology

- Streamflows would not be interrupted, and properly sized culverts would be used in all temporary in-channel fills that could impound water.
- At temporary bridge-crossing sites, streambanks disturbed by bridge foundations would be protected by boulders or riprap to prevent streambank erosion and lateral migration of the stream channel. These materials would be removed when the temporary road is removed and the corridor is restored to preconstruction conditions.
- Stream channel gradients would be maintained where channel modifications are required for temporary road crossings.
- Temporary bridge abutments, structural foundations, and supports would avoid modification of stream channels and would minimize encroachment of the stream 100-year floodplain. These facilities would not cause channel constriction and subsequent channel scouring.
- Bridge support structures would not be placed in the streambed.

- When a road stream crossing is necessary, the design of the approach and crossing would be perpendicular to the channel. The crossing would be located where the channel is well-defined, unobstructed, and straight.

ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

Several actions considered by the interdisciplinary planning team were not incorporated into the proposed alternatives. According to NPS Directors Order #12, reasons to eliminate an alternative as infeasible include technical infeasibility, inability to meet project objectives or resolve need, conflicts with plans, policies or laws “such that a major change” would be needed to implement, and duplication with other, less environmentally damaging, less expensive or more feasible options, or has too great an environmental impact (NPS 2001c).

This section describes those restoration activities that were eliminated from further consideration and the basis for excluding them from analysis in this environmental impact statement.

In addition to options 1 and 2 for zone 1A that were carried forward for analysis, two additional options were considered for stabilizing the gully within the steep hillside in zone 1A immediately below the ditch maintenance road. One option would be to stabilize only the steep edges along the gully within this zone. This option was dismissed from further consideration because it would not provide enough long-term stabilization of the hillside. As noted previously, lateral tension cracks have been observed in the historical fill slopes just outside of and roughly parallel to the lateral edges of the gully. Stabilizing only the area along the gully may prevent future expansion of the gully but would not prevent future potential failure of the slope adjacent to the gully. This option would not be consistent with the purpose and need of the project.

The second option eliminated from further consideration for the stabilization of zone 1A involved filling in the gully, grading it to the original contour of the hillside, and then stabilizing with rock buttresses. The interdisciplinary team considered using debris that had been deposited in zones 2 and 4 as the fill for zone 1A. To transport debris from zone 4 to the bottom of zone 1A would require either constructing a haul road through the project area or using helicopters. Constructing a haul road within the upland area along Lulu Creek would adversely impact sensitive cultural resources and would require removing a large number of mature trees within the project area, which was deemed unacceptable. The amount of material required to fill the gully, approximately 16,700 cubic yards, would require numerous helicopter flights to transport the needed material to zone 1A. The costs to implement the use of helicopters for debris transport would be prohibitive.

Removing large amounts of debris, such as from the alluvial fan in zones 2 and 3 and debris and sediment deposited in the wetland of zone 4, from the project area to an offsite location was also considered. Again, given the remote location and steep terrain of the area, the only way to effectively remove the amount of debris needed to restore the area would be by helicopters, which was deemed to be cost prohibitive.

During the planning process, consideration was given to the creation of a catch basin for sediment at the upstream portion of the Lulu City wetland. This basin would provide additional storage of sediment from natural or human-caused debris and sediment flows that may occur in the future. This portion of the project area is within designated wilderness, and this engineered solution for future debris and sediment events was considered inconsistent with NPS wilderness policy. In addition, the scope of this project is to restore the area from the damage that resulted from the 2003 breach, and planning for future debris and sediment flows is beyond that scope.

PROCESS TO IDENTIFY THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Alternative D has been identified as the NPS preferred alternative. The identification of the NPS preferred alternative is based on the overall ability of the alternative to resolve the need for the plan, meet the project objectives to a high degree, and minimize adverse effects on the resources of the park. Although all of the action alternatives would meet these criteria, additional factors were considered in the development of the NPS preferred alternative. The NPS preferred alternative was developed to achieve a high level of ecological restoration based on the ecological reference conditions in a relatively short time. It also considers that restoration of ecological reference conditions is occurring naturally in some locations, such as in areas of zones 2 and 3, and that allowing passive restoration to continue would be cost effective and reduce the impacts of implementation to important resources such as wilderness. As a result, the NPS preferred alternative is a composite of the other action alternatives that combines the most effective actions that could be accomplished within the project budget. The following discussion provides the rationale for the identification of the components of the NPS preferred alternative.

The greatest benefit of actions considered in all alternatives was the improved ecological processes and biodiversity achieved by restoring the Lulu City wetland in zone 4 through debris removal, planting of tall willow, and actively restoring hydrologic processes, including return of the Colorado River channel to the center of the wetland. Additionally, increased plantings combined with actively restored hydrologic conditions would allow more complete recovery of vegetation communities over a larger area and within a shorter time.

Hydrologic recovery and restoration of historical fluvial processes would be more complete and take less time through increased debris removal in the Lulu Creek alluvial fan and in zone 4, and by reconnecting the river channel to the floodplain in zone 3. These actions, combined with channel restoration in the Lulu City alluvial fan and the Lulu City wetland, would reestablish historical groundwater and surface water relationships in the Lulu City wetland, and would reestablish historical channel alignments and geometries in both the area of the alluvial fan and in the Lulu City wetland. In addition, long-term benefits of decreased sedimentation outside the project area would be achieved through the removal of these concentrated sediment deposits and through improved wetland sediment capture functions in zones 3 and 4.

Substantial advantage of improved long-term wilderness character would also be achieved in the NPS preferred alternative. Reduction of the physical evidence of damage caused by the breach through removal of the large debris deposits in the Lulu Creek alluvial fan and restoring the ecological and hydrologic reference conditions in the Lulu City wetland would result in large improvements to the untrammeled and natural qualities of wilderness.

The National Park Service has considered the availability of funds to implement the project and has determined that to meet the objectives of the project within available funds, restoration actions with relatively less benefit would not be included in the NPS preferred alternative. Relatively little advantage was achieved through maximum active restoration of Lulu Creek (zone 2 above the alluvial fan) because several hydrological and ecological functions are returning naturally under existing conditions. The most cost-effective alternative for zone 2 upstream of the alluvial fan is to stabilize steep banks and revegetate with native vegetation, as described in alternative B. This was modified slightly for the NPS preferred alternative to use small mechanized equipment rather than hand tools. This would shorten the time to execute the project and reduce the short-term impacts on project area resources and visitor experience.

In zone 1A, option 1 to stabilize existing slopes, using a tie-back anchoring system was determined to be the most effective alternative because it would meet objectives to stabilize the breach scar, cost less than option 2, and would

- contribute smaller impacts on the untrammeled quality of the adjacent wilderness because soil nails in existing slopes would involve less human manipulation;
- provide increased immediate and long-term stability within the scar with less concern for compaction or sloughing of large amounts of fill material; and
- result in less impact on park resources from implementation and the amounts of mechanized equipment activity.

Table 2.4 presents the action alternative that is the basis for the NPS preferred alternative in each zone and area within the zone.

Table 2.4: Summary of the NPS Preferred Alternative

Zone/Area	Alternative
Zone 1A	In situ stabilization using a tie back anchor system (option 1)
Zone 1B (area A)	B
Zone 2 (area B)	B
Zone 2 (area C)	B
Zone 2 (area E)	B
Zone 2 (area F)	E
Zone 2 (area G)	E
Zone 3 (area H)	B
Zone 3 (area K)	B
Zone 3 (area L)	C
Zone 3 (area M)	C
Zone 3-4 (area N)	C
Zone 4 (area O)	E
Zone 4 (area P)	C
Zone 4 (area Q)	E
Zone 4 (area S)	E

HOW EACH ALTERNATIVE ACHIEVES REQUIREMENTS OF THE NATIONAL ENVIRONMENTAL POLICY ACT

According to section 101 of the National Environmental Policy Act, the policy of the federal government is "to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans." Section 101(b) of the act identifies six conditions that define success in achieving this policy. This section states that federal agencies should, through the selection of the alternative to be implemented, attempt to:

1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;
3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
4. Preserve important historical, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment that supports diversity and variety of individual choice;
5. Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities; and
6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

DISCUSSION OF ALTERNATIVES

1. Fulfill the Responsibilities of Each Generation as Trustee of the Environment for Succeeding Generations

Alternatives C, D, and E meet this criterion to a high degree in that they maximize, through extensive restoration and stabilization, benefits to the environment that can be enjoyed by succeeding generations. These alternatives provide for the long-term protection of natural resources, including wilderness, in a state that reflects ecological conditions that existed before the 2003 breach. Alternative A (no action / continue current management) and alternative B rely more on passive restoration of ecological processes and conditions that would take 200 years or more to return to a stable state that would not necessarily be reflective of conditions that existed prior to the breach.

2. Assure for All Americans Safe, Healthful, Productive, and Esthetically and Culturally Pleasing Surroundings

All of the action alternatives would meet this criterion to varying degrees because bank stabilization and revegetation of impacted areas would increase the long-term productivity of the project area and produce more aesthetically pleasing surroundings. Alternatives D and E would accomplish this to a much higher degree than alternatives B and C because of the extent of restoration activities, including the removal of the alluvial fan in zones 2 and 3. Under these alternatives, once restoration is complete, upland and wetland habitats would be greatly enhanced, diversity would increase, and the effects of sedimentation would decrease. These restoration activities would result in a sustainable system that ensures a highly productive environment for future generations. Alternative B provides for an esthetically pleasing environment, at least initially, compared to alternatives C, E, and E because it does not rely on the use of exclosure fences to protect vegetation as the other alternatives do. For some visitors to the area, fences may detract from the scenery. However, over time, as vegetation recovers, the adverse effects of the fences would be less, and fences would be removed in 15 to 20 years. Alternatives C, D, and E, however, involve the restoration of a larger portion of the project area than alternative B and thus after the fences are removed would be more reflective of pre-breach conditions and would have greatly improved the natural quality of the wilderness. In the long term, alternatives C, D, and E would result in the project area being more aesthetically pleasing.

3. Attain the Widest Range of Beneficial Uses of the Environment without Degradation, Risk of Health or Safety, or Other Undesirable and Unintended Consequences

Under all of the action alternatives, the restoration of the area would provide a range of beneficial recreation, education, and scientific uses. However, alternatives C, D, and E would provide a more aesthetically pleasing and biologically diverse environment in which to recreate and provide a wilderness experience more reflective of pre-breach conditions. Because of the National Park Service's extensive experience in managing park resources, undesirable and unintended consequences associated with these beneficial uses can be anticipated and avoided or mitigated.

4. Preserve Important Historic, Cultural, and Natural Aspects of Our National Heritage and Maintain, Wherever Possible, an Environment that Supports Diversity and Variety of Individual Choice

All of the action alternatives would restore, to varying degrees, the natural aspects of the project area. Alternatives C, D, and E would restore and provide long-term preservation of wetland, wilderness, hydrologic, and biologic resources because the creek and river channels would be stabilized to accommodate the natural range of flows in lower zone 2 and upper zone 3. Large areas of wetland habitat would be restored to a tall willow complex, which would enhance biologic diversity in the project area. Alternative B would rely more on passive restoration and small-scale stabilization of easily eroded areas. As a result, it would take a very long time to reach a stable condition that may not reflect pre-breach conditions and would therefore not provide a high level of preservation of natural resources.

There are few cultural resources within the area to be actively restored. With mitigation measures and best management practices employed under each action alternative, cultural resources would be protected and preserved.

5. Achieve a Balance between Population and Resource Use that Will Permit High Standards of Living and a Wide Sharing of Life's Amenities

In terms of the proposed project, the phrase "wide sharing of life's amenities" was taken to mean those alternatives that offer the most benefits for plants, wildlife, and wilderness, as well as for human visitors. The action alternatives would offer opportunities for people to experience, enjoy, and learn from the restored landscape through educational materials. The proposed project would restore the balance of preservation of natural resources while allowing visitor use and appreciation of those resources.

6. Enhance the Quality of Renewable Resources and Approach the Maximum Attainable Recycling of Depletable Resources

Enhancing the quality of renewable resources and recycling of depletable resources are not applicable to the restoration of the project area.

THE ENVIRONMENTALLY PREFERABLE ALTERNATIVE

The National Park Service is required to identify the environmentally preferable alternative in its National Environmental Policy Act documents for public review and comment. Guidance from the Council on Environmental Quality (1981) states that the environmentally preferable alternative will promote the national environmental policy as expressed in section 101 of the National Environmental Policy Act. Further, it is "the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources."

Alternative E has been identified as the environmentally preferable alternative. Among the alternatives considered, alternative E would provide for the most expedient and effective recovery to ecological reference condition for the project area. Alternative E would be more effective than the other action alternatives (alternatives B, C, and D) in restoring ecological processes, restoring and preserving wilderness character over the long term, and providing for the highest level of channel stability and reduced sedimentation over the greatest extent of the project area. Under alternative E, more wetland habitat would be restored to a tall willow complex than the other alternatives because it removes the greatest amount of sediment from the 2003 breach and prior debris flows and would restore flow to the center of the wetland through the river's historical alignment. This would result in the restoration of the Lulu City wetland to a state most reflective of the reference conditions. By restoring the largest area of wetland habitat, alternative E achieves the highest level of wetland functions such as sediment and flood storage capabilities, enhanced wildlife habitat, and improved water quality.

Under alternative E compared to the other alternatives, vegetation, including a more sustainable tall willow community, would recover more completely, over a larger area, and within a shorter period of time from increased plantings and improved hydrologic conditions. Hydrologic recovery in the project area would also be more complete and take less time because of decreased sedimentation, removal of debris, and reconnection of the river channel to the floodplain to restore historical fluvial processes.

In the long term wilderness character would be more improved in alternative E than the other alternatives through a variety of ways including; a reduction in the physical evidence of the damage and manipulation caused by the breach, restoration of ecological and hydrologic processes, and increased stabilization and revegetation that would improve the wilderness qualities. These would substantially improve the untrammeled, natural, and primitive and unconfined recreation qualities of wilderness.

Alternative E however has the greatest level of short-term adverse effects on resources such as wilderness and natural soundscapes than the other alternatives. The wilderness qualities would be highly impacted as a result of the increased excavation throughout the project area, the creation of larger debris terraces compared to alternatives C and D, and the development of a temporary access road within zones 3 and 4.

The short-term effects on natural soundscapes would also be greatest under alternative E compared to the other alternatives. The level of debris removal under alternative E is nearly six times greater than the other alternatives as a result of the restoration actions to be implemented in the Lulu City wetland. The amount of construction equipment that would be needed and the length of time that the machinery would be operated to achieve a high level of restoration under alternative E would have greater impacts on the natural soundscape than the other alternatives. However, these short-term adverse effects would be implemented to support the restoration activities that would lead to the greatest level of long-term productivity and preservation of park resources.

Alternative B would result in fewer short-term, adverse impacts on natural resources in the project area; however, it would also result in less restored and stabilized area and would not provide as much ecological benefit as alternative E. Because alternative B relies predominantly on passive restoration of the project area, it would likely not achieve the ecological reference conditions within 200 years.

Alternative A (no action / continue current management) was not considered environmentally preferable because it would not stabilize debris within the project area. Debris in the project area would continue to erode and degrade downstream natural resources. Because alternative A relies on passive restoration of the project area, it would likely take more than 200 years to achieve the ecological reference conditions.

ALTERNATIVES SUMMARY

The following tables summarize the alternatives. Table 2.5 summarizes the elements of the alternatives being considered. Table 2.6 lists the treatments and acreage affected for each zone under each alternative. Table 2.7 analyzes how well each alternative meets the objectives. The “Environmental Consequences” chapter describes the effects on each impact topic under each of the alternatives, including the impact on recreational values and visitor experience; these impacts are summarized in Table 2.8. Please refer to figures 2.2 to 2.7 for locations of the zones and areas within zones being referred to in the tables, and refer to the alternatives maps for a brief description of the proposed actions (see figures 2.2 through 2.29).

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Table 2.5: Summary of Alternative Elements

Zone / Area within Zone	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Zone 1A	No stabilization efforts would be taken. This is likely to violate the court mandate to stabilize this area as stipulated in the 2008 settlement between the United States and the Water Supply and Storage Company.	**Option 1** Stabilize existing scar using a tie back anchor system. Soil anchor nails would be used to stabilize the scar and steel mesh would be placed over the slope face. Specific surface treatments such as geocell installation or rock mulching may be required to control shallow, surficial flow slides and provide erosion protection. Optional components include installing a reinforced earth cap along the ditch road or use vertically-installed micropiles to provide further stabilization. or **Option 2** Backfill existing scar with compacted, reinforced earth fill to restore the original, pre-breach topography. Fill would be compacted in lifts over the existing fill and reinforced with synthetic geogrid reinforcement and anchored into the existing hillslope using a tieback system. Excavate into the slope of the uphill side of the existing culvert pipes and install a third culvert barrel through the breach area. Fill material would be obtained from a commercial source or possibly from Long Draw Reservoir.	Same as Alternative B	**Option A** Stabilize existing scar using a tie back anchor system. Soil anchor nails would be used to stabilize the scar and steel mesh would be placed over the slope face. Specific surface treatments such as geocell installation or rock mulching may be required to control shallow, surficial flow slides and provide erosion protection. Optional components include installing a reinforced earth cap along the ditch road or use vertically-installed micropiles to provide further stabilization.	Same as Alternative B

Table 2.5: Summary of Alternative Elements (Continued)

Zone / Area within Zone	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Zone 1B / A	No active restoration actions would be conducted.	Stabilize through revegetation and recontouring in spot locations throughout the gully.	Stabilize undercut slopes through major recontouring and revegetate with native vegetation throughout the gully.	Stabilize through revegetation throughout the entire gully using small mechanized equipment.	Fill in the gully to pre-2003 contours using debris deposits from within zone 1B and 2, and revegetate with native vegetation.
Zone 2 / B	No active restoration actions would be conducted.	Stabilize banks through revegetation and recontouring in spot locations. Leave the channel as is.	Establish a single channel through this area with step-pools. Stabilize the banks of the single channel with boulders and large woody debris. Fill the old channels with debris and stabilize. Revegetate with upland species.	Stabilize banks through revegetation and recontouring in spot locations using small mechanized equipment. Leave the channel as is.	Establish a single channel through this area. Enhance and/or create step-pools within the single channel. Remove debris and use it fill the gully in the upper portions of zone 1B. Stabilize the banks of the single channel with boulders and large woody debris. Revegetate with upland species.
Zone 2 / C	No active restoration actions would be conducted.	Implement spot revegetation and recontour in spot locations as necessary to stabilize banks along the multiple braided channels.	Implement spot revegetation as necessary using upland species. Enhance existing step-pools and create new step-pools as dictated by slope and grade utilizing large woody debris.	Implement spot revegetation as necessary to stabilize banks using small mechanized equipment along the multiple braided channels.	Implement spot revegetation as necessary using upland species. Enhance existing step-pools and create new step-pools as dictated by slope and grade utilizing large woody debris. Refer to reference stream conditions.
Zone 2 / D	No actions conducted in this area.	Same as alternative A	Same as alternative A	Same as alternative A	Same as alternative A
Zone 2 / E	No active restoration actions would be conducted.	Stabilize the area through revegetation outside of the main channel and above the high water mark. Recontour in spot locations and stabilize areas along the channel utilizing boulders from within zone 2 that are moveable by human power.	Implement spot revegetation as necessary using upland species. Enhance existing step-pools and create new step-pools as dictated by slope and grade utilizing large woody debris. Recontour banks and stabilize areas with boulders. Relocate and recontour debris from within zone 2 to create a more stable bank configuration. Revegetate areas outside of the active channel and above the high water mark.	Stabilize the channel through revegetation outside of the main channel and above the high water mark. Recontour in spot locations and stabilize areas along the channel utilizing boulders from within zone 2.	Stabilize banks through recontouring. Enhance existing step-pools and create new step-pools as dictated by slope and grade utilizing large woody debris. Reorient and/or install boulders and large woody debris to fill in areas that were scoured by the breach event. Utilize debris from the alluvial fan farther downstream. Revegetate areas outside of the active channel and above the ordinary high water mark using upland species.

Table 2.5: Summary of Alternative Elements (Continued)

Zone / Area within Zone	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Zone 2 and Zone 3 / F	No active restoration actions would be conducted.	Revegetate areas in the alluvial fan above the ordinary high water mark where there is bare soil. Stabilize areas along the banks of the outer most channels using boulders from within zone 2.	Excavate and remove debris within 5 to 10 feet of either side of the channel to a depth consistent with upstream conditions. Create terraces with this debris in area G. Establish a single channel with step pools through the alluvial fan and stabilize the banks of the main channel with boulders to lessen the availability of breach debris and sediment into the system. Revegetate the excavated area with riparian species.	Remove the debris from the alluvial fan and along the Colorado River. Create terraces with this debris in area G. Restore the alluvial fan to a single channel, create step pools, and stabilize the banks. Revegetate bare areas with riparian species and protect with browsing exclosures.	Same as alternative D
Zone 2 / G	No actions conducted in this area.	No actions conducted in this area.	Create terraces in this area from the debris removed from the alluvial fan (area F). Revegetate the terraces with upland species.	Same as alternative C	Same as alternative C
Zone 3 / H	No active restoration actions would be conducted.	Revegetate in areas outside of the active channel utilizing willow and other riparian species.	Relocate large woody debris in spot locations to lessen the availability of breach debris and sediment into the system. Use debris to enhance step-pool and pool-riffle complex development. Revegetate in areas outside of the active channel and above the ordinary high water mark utilizing willow and other riparian species. Implement individual plant and small browsing exclosure fences to protect these plantings.	Revegetate in areas outside of the active channel utilizing willow and other riparian species using small mechanized equipment if necessary.	Same as alternative C
Zone 3 / I	No actions conducted in this area.	Same as alternative A	Same as alternative A	Same as alternative A	Storage area for debris removed from the alluvial fan (area F) and the Lulu City wetland (areas O and P). Revegetate the debris with upland species.
Zone 3 / J	No actions conducted in this area.	Same as alternative A	Same as alternative A	Same as alternative A	Same as alternative A

Table 2.5: Summary of Alternative Elements (Continued)

Zone / Area within Zone	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Zone 3 / K	No active restoration actions would be conducted.	Revegetate in areas outside of the active channel utilizing willow and other riparian species.	Leave the channel in its current condition and reconnect the surface water supply to the historical floodplain. Revegetate bare areas along the western bank with riparian species and implement small browsing exclosure fences.	Revegetate in areas outside of the active channel utilizing willow and other riparian species. Utilize small mechanized equipment if necessary.	Same as alternative C
Zone 3 / L	No active restoration actions would be conducted.	Revegetate in areas outside of the active channel utilizing willow and other riparian species.	Make a series of cuts in the berm deposits along the eastern bank of the Colorado River channel and allow water to overflow to the east during high flow events.	Make a series of cuts in the berm deposits along the eastern bank of the Colorado River channel and allow water to overflow to the east during high flow events.	Excavate all berm deposits along the eastern bank of the Colorado River channel and allow water to overflow to the east during high flow events.
Zone 3 / M	No active restoration actions would be conducted.	Same as alternative A	Provide for flood storage in this area by reconnecting the hydrology between the wetland area and the active channel.	Same as alternative C	Same as alternative C
Zone 3 / N	No active restoration actions would be conducted.	Establish a staging area and temporary camp for restoration workers.	Dutch Creek debris storage area for debris removed from the Lulu City wetland (areas O and P). Revegetate debris terraces with upland species. Establish a staging area and temporary camp for restoration workers.	Same as alternative C	Same as alternative C
Zone 3 / Haul Road	No haul road established.	Same as alternative A	Same as alternative A	Same as alternative A	Haul road constructed on east bank of Colorado River for mechanized equipment access. To be reclaimed following completion of restoration activities.
Zone 4 / O	No active restoration actions would be conducted.	No active restoration actions would be conducted.	Excavate debris and sediment along a new alignment at the north end of the wetland to allow the main channel of the Colorado River to return to the historical channel in the center of the wetland. Stabilize the channel above this diversion point with boulders to prevent upstream cutting.	Excavate the debris to create a sustainable channel configuration that would allow the flow of the Colorado River to enter the historical channel in the center of the wetland. Stabilize the channel above this diversion point with boulders to prevent upstream cutting.	Same as alternative D

Table 2.5: Summary of Alternative Elements (Continued)

Zone / Area within Zone	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Zone 4 / P	No active restoration actions would be conducted.	Revegetate bare areas with wetland turf or sedge sprigs. Stabilize head-cuts in spot locations. Protect erosion prone banks with rocks from zone 4.	Remove 2003 debris or as necessary to restore hydrologic conditions suitable for a tall willow complex and to maintain the historical Colorado River channel location. Revegetate this area with willows and wetland species and implement browsing exclosure fences.	Remove 2003 debris or as necessary to restore hydrologic conditions suitable for a tall willow complex and to maintain the historical Colorado River channel location. Revegetate this area with willows and wetland species and implement browsing exclosure fences.	Remove 2003 plus an additional 5-6 times additional debris to restore conditions suitable for a tall willow complex and to maintain the historical Colorado River channel location. Revegetate this area with willows and implement browsing exclosure fences.
Zone 4 / Q	No active restoration actions would be conducted.	Revegetate bare areas with wetland turf or sedge sprigs. Stabilize head-cuts in spot locations.	Excavate the entire length of the channel to approximate historical channel depth, width, and slope. Revegetate bare areas with willows and implement browsing exclosure fences. Implement bank stabilization to accommodate the increased flow and reduce erosion.	Implement bank stabilization to accommodate the increased flow and reduce erosion. Revegetate bare areas with willows, sedges, and hydric grasses and implement browsing exclosure fences. Excavate two reaches within the historical channel to allow for flow through the channel.	Same as alternative C
Zone 4 / R	No actions conducted in this area.	Same as alternative A	Same as alternative A	Same as alternative A	Same as alternative A
Zone 4 / S	No active restoration actions would be conducted.	Same as alternative A	Fill river channel with materials suitable to establish conditions for a tall willow complex and to minimize draining restored upgradient areas. Revegetate this area with willows and implement browsing exclosure fences.	Fill river channel with materials suitable to establish conditions for a tall willow complex and to minimize draining restored upgradient areas. Revegetate this area with willows and implement browsing exclosure fences.	Fill river channel with materials suitable to establish conditions for a tall willow complex and to minimize draining restored upgradient areas. Revegetate this area with willows and implement browsing exclosure fences.
Zone 4 / T	No active restoration actions would be conducted.	Same as alternative A	Same as alternative A	Same as alternative A	Remove debris to expose surface of pre-existing fen. Revegetate with fen species and implement browsing exclosure fences.
Costs[a] With Zone 1A Option 1		$4,141,880	$11,131,409	$9,333,546	$16,974,329
With Zone 1A Option 2		$5,537,837	$12,726,830	NA	$18,569,750

a. Costs are estimated in 2011 dollars. The error of the estimates is within the accepted industry accuracy range of Class C estimates of -30% to +50% (NPS 2007b).

Table 2.6: Summary of Estimated Quantities and Areas Treated

Feature	Metric	Alternative B				Alternative C				Alternative D				Alternative E			
		Zone 1B	Zone 2	Zone 3	Zone 4	Zone 1B	Zone 2	Zone 3	Zone 4	Zone 1B	Zone 2	Zone 3	Zone 4	Zone 1B	Zone 2	Zone 3	Zone 4
Revegetate banks and exposed surfaces	acre	0.2	0.8	0.4	1	0.3	4	5	10	0.5	3	5	9	0.4	3	6	22
Shape and/or stabilize channelbanks	feet	300	1,000	200	--	700	5,800	900	--	--	3,100	--	--	--	6,400	1,600	--
Fill braided channel	cubic yard	--	--	--	--	--	700	--	2,400	--	--	--	5,100	14,400	700	--	2,700
Create single stream channel	feet	--	--	--	--	--	1,100	--	--	--	800	--	--	--	1,100	--	--
Create step pools and pool-riffle complexes in channel	No. (feet)	--	--	--	--	--	22[a] (300)	10 (200)	--	--	10[a] (200)	--	--	--	22[a] (300)	10 (200)	--
Remove debris fan material	cubic yard	--	--	--	--	--	1,900	--	--	--	6,600	--	--	--	6,600	--	--
Stockpile surplus debris	cubic yard	--	--	--	--	--	6,700	29,300	--	--	6,700	29,300	--	--	6,600	44,900	--
Excavate east streamside berm	feet (cubic yards)	--	--	--	--	--	--	900 (300)	--	--	--	900 (300)	--	--	--	900 (1000)	--
Browsing exclosures	feet	--	--	--	--	--	--	4,000	13,300	--	5,600	--	7,700	--	5,600	4,000	15,100
Excavate debris	cubic yards	--	--	--	--	--	--	--	16,300	--	--	--	12,000	--	--	--	69,600
Excavate debris for Colorado River at north end of wetland	cubic yards	--	--	--	--	--	--	--	--	--	--	--	5,300	--	--	--	5,300
Restore historical Colorado River channel through wetland	feet (cubic yards)	--	--	--	--	--	--	--	3,700 (6,600)	--	--	--	500 (900)	--	--	--	3,700 (6,100)
Excavate debris from fen	cubic yards	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,600
Construct temporary haul road	feet (acre)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,600 (5)

[a] This estimate includes step pools within the alluvial fan area that occur in zones 2 and 3.

Table 2.7: Analysis of How Alternatives Meet Objectives

Restoration Objective	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Restore appropriate stream hydrological and groundwater processes	Does not meet objective. No actions would be taken to restore hydrologic or groundwater processes.	Meets objective to a small degree. No actions would be taken to restore hydrologic or groundwater processes.	Meets the objective to a large degree. Surface hydrology and groundwater processes would be greatly improved by enhancing step-pools, riffle-pool complexes, reducing stream braiding, and removing sediments along the banks to restore the connection to the water table. Surface and groundwater hydrologic conditions would be restored through removal of large debris deposits in the wetland in zone 4 and reconnecting the channel to the floodplain in zone 3.	Meets the objective to a large degree. Surface and groundwater hydrologic conditions would be restored through removal of large debris deposits in the wetland in zone 4 and reconnecting the channel to the floodplain in zone 3. Surface hydrology and groundwater processes would take a longer time to improve as natural processes would be relied upon. Some recontouring of banks in zone 2 may provide improved connectivity to the water table in this area.	Meets the objective to a large degree. Surface hydrology and groundwater processes would be greatly improved by enhancing step-pools, riffle-pool complexes, reducing stream braiding, and removing sediments along the banks to restore the connection to the water table. Surface and groundwater hydrologic conditions would be restored through removal of large debris deposits in the wetland in zone 4 and reconnecting the channel to the floodplain in zone 3.
Restore appropriate native plant communities	Does not meet objective. No activities would be undertaken to restore native vegetation to the project area. Vegetation would recover passively and would not achieve pre-breach or reference conditions.	Meets objective to a small degree. Activities would be conducted to revegetate areas of highly unstable banks and slopes and bare areas in the wetland. Recovery of vegetation would not achieve pre-breach or reference conditions.	Meets objective to a large degree. Revegetation of recontoured slopes and banks and activities to restore hydrologic conditions in the wetland would result in recovery of vegetative communities to pre-breach or reference conditions.	Meets objective to a moderate degree. Activities would be conducted to revegetate areas of highly unstable banks in zones 1B, 2, and 3. The level of vegetative recovery of riparian and upland communities in this area would be slightly less than alternative C. Activities to restore hydrologic conditions in the wetland would result in recovery of tall willow communities in this zone reflective of pre-breach or reference conditions.	Meets objective to a large degree. Revegetation of recontoured slopes and banks and activities to restore hydrologic conditions in the wetland would result in recovery of vegetative communities to pre-breach or reference conditions.
Restore the stability of the hillside below the breach site	Does not meet objective. No actions would be taken to stabilize the hillside.	Fully meets objective. Actions would be taken to stabilize the hillside.	Fully meets objective. Actions would be taken to stabilize the hillside.	Fully meets objective. Actions would be taken to stabilize the hillside.	Fully meets objective. Actions would be taken to stabilize the hillside.

Table 2.7: Analysis of How Alternatives Meet Objectives (Continued)

Restoration Objective	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Restore wilderness character	Does not meet objective. No actions would be taken to restore wilderness character under this alternative. The degraded conditions to the untrammeled and natural qualities of wilderness, and primitive and unconfined recreation in wilderness would persist as a result of the damages caused by the breach event.	Meets objective to a small degree. Limited efforts to lessen the availability of breach debris and sediments to the system through revegetation and spot stabilization would result in some slight improvements to the untrammeled and natural qualities of wilderness and the primitive and unconfined recreation in wilderness.	Meets objective to a large degree. Implementation of revegetation, bank stabilization, debris and sediment removal, and reconfiguration of the river channel to its historic alignment would restore greatly the untrammeled and natural qualities of wilderness over a large portion of the project area. Debris and sediment remaining in the alluvial fan in zone 2 would continue to degrade the natural quality of wilderness to a small degree. Creation of terraces from excavated debris and browsing exclosures would also adversely affect the untrammeled quality of wilderness; however these effects would be short-term. Restoration actions would greatly improve the opportunities for solitude or primitive and unconfined recreation in wilderness by greatly reducing evidence of the 2003 breach.	Meets objective to a large degree. Implementation of revegetation, minor bank stabilization, large scale debris and sediment removal, and reconfiguration of the river channel to its historic alignment would restore greatly the untrammeled and natural qualities of wilderness particularly in zones 3 and 4. The removal of the debris in the alluvial fan in zone 2 and debris from zone 4 would greatly improve the natural quality of wilderness by restoring to reference condition ecological and hydrologic processes. Creation of terraces from excavated debris would also adversely affect the untrammeled quality of wilderness; however these effects would be short-term. Restoration actions would improve the opportunities for solitude or primitive and unconfined recreation in wilderness by greatly reducing evidence of the 2003 breach.	Meets objective to a large degree. Implementation of revegetation, bank stabilization, debris and sediment removal, and reconfiguration of the river channel to its historic alignment would restore greatly the untrammeled and natural qualities of wilderness over a large portion of the project area. The removal of the debris in the alluvial fan in zone 2 and debris from zone 4 would greatly improve the natural quality of wilderness by restoring to reference condition ecological and hydrologic processes. Creation of terraces from excavated debris would also adversely affect the untrammeled quality of wilderness; however these effects would be short-term. Restoration actions would greatly improve the opportunities for solitude or primitive and unconfined recreation in wilderness by greatly reducing evidence of the 2003 breach.
Restore wildlife habitat	Does not meet objective. No actions would be taken to revegetate areas disturbed by the 2003 breach. Vegetation would recover passively and would not achieve pre-breach or reference conditions.	Meets objective to a small degree. Activities would be conducted to revegetate areas of highly unstable banks and slopes and bare areas in the wetland. This would provide limited improvement to terrestrial wildlife habitats. No action would be taken to remove the large debris and sediment deposits which would continue to enter the system and degrade habitat for aquatic wildlife.	Fully meets objective. Actions would be taken to restore native vegetation throughout the project area. Restoration of upland, riparian, and wetland habitats would provide improved high quality habitat for terrestrial wildlife species.	Meets objective to a large degree. Activities would be conducted to revegetate areas of highly unstable banks and slopes in zones 1B, 2, and 3. This would provide only limited improvement to wildlife that use upland and riparian terrestrial habitats. Restoration of hydrologic and vegetative conditions in the wetland would improve wildlife habitat to a high degree.	Fully meets objective. Actions would be taken to restore native vegetation throughout the project area. Restoration of upland, riparian, and wetland habitats would provide improved high quality habitat for terrestrial wildlife species.

Table 2.7: Analysis of How Alternatives Meet Objectives (Continued)

Restoration Objective	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Restore aquatic habitat	Does not meet objective. No actions would be taken to lessen the availability of breach debris or sediments to the system and aquatic habitats would continue to be disturbed or degraded.	Meets objective to a small degree. Activities would be conducted to revegetate areas of highly unstable banks and slopes and bare areas in the wetland which would lessen to a very minor level the availability of breach debris and sediment to the aquatic system. No action would be taken to remove the large debris and sediment deposits which would continue to enter the system and degrade habitat for aquatic wildlife.	Meets objective to a large degree. Recontouring of slopes and steep banks and restoration of upland, riparian, and wetland habitats would lessen to a high level the availability of breach debris and sediments to the system. This combined with the removal of large debris deposits in the wetland would improve habitat for aquatic wildlife in this zone; however with only a portion of the alluvial fan in zone 2 removed, there would be breach debris and sediment available for transport downstream that would continue to adversely impact aquatic wildlife to a small degree.	Meets objective to a large degree. Activities would be conducted to recontour and revegetate areas of highly unstable banks and slopes in zones 1B, 2, and 3 which would lessen moderately the availability of breach debris and sediment to the aquatic system. Removal of large debris deposits in the alluvial fan in zone 2 and in the wetland in zone 4 would substantially improve habitat for aquatic wildlife.	Fully meets objective. Recontouring of slopes and steep banks and restoration of upland, riparian, and wetland habitats would lessen to a high level the availability of breach debris and sediments to the system. This combined with the removal of large debris deposits in the alluvial fan in zone 2 and in the wetland in zone 4 would substantially improve habitat for aquatic wildlife.
Restore water quality in the affected area and downstream	Does not meet objective. No action would be taken to reduce impacts on water quality. Water quality would continue to be degraded particularly during periods of high flow.	Meets objective to a small degree. Localized spot revegetation and stabilization of banks would improve water quality because of the decreased contribution of debris and suspended sediments to the Colorado River and the Lulu City wetland.	Meets objective to a large degree. Large-scale recontouring of steep slopes and banks over a large portion of the project area and improved hydrologic conditions in the wetland of zone 4 would greatly improve water quality by removing much of the suspended sediment and sediment sources in the project area. There would continue to be some erosion of debris and sediment deposits in the alluvial fan in zone 2 that would continue to have small impacts on water quality.	Meets objective to a large degree. Minor recontouring of banks in zones 2 and 3 would improve water quality to a moderate degree by reducing sources of sediment in these zones. Removal of large sediment deposits in the alluvial fan in zone 2 and in zone 4 would provide a high level of improvement to water quality.	Fully meets objective. Large-scale recontouring of steep slopes and banks over a large portion of the project area and improved hydrologic conditions in the wetland of zone 4 would greatly improve water quality by removing much of the suspended sediment and sediment sources in the project area

Table 2.8: Summary of Environmental Consequences

Impact Topic	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Wilderness Character	Damages from the 2003 breach would continue to confine, limit, and restrain ecological integrity and would have long-term, moderate to major adverse impacts on the untrammeled quality of wilderness. Under the no action alternative, there would be no impacts on the undeveloped wilderness quality. Impacts on the ecological and hydrologic processes would continue to be altered by the 2003 breach and would result in long-term, adverse impacts of moderate to major intensity on the natural quality of wilderness. The visual impacts of the 2003 breach would continue and would have long-term, localized, moderate to major adverse impacts on opportunities for solitude or primitive and unconfined recreation in wilderness. Cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. This alternative's contribution to these effects would be small.	Implementation activities to provide limited revegetation and stabilization would have short-term, moderate, adverse impacts on the untrammeled wilderness character. Long-term impacts from limited revegetation and stabilization would be negligible and beneficial relative to alternative A. Preparation of soil, the presence of erosion control mats and line camps, disturbance of surface waters during bank stabilization, and the use of mitigating measures during implementation would result in short-term, adverse impacts of minor to moderate intensity on the natural wilderness character. Long-term impacts on the natural wilderness character from limited restoration of ecological reference conditions would be negligible to minor and beneficial relative to alternative A. During implementation, temporary developments would result in localized, short-term, and adverse impacts of moderate intensity to the undeveloped wilderness character. Implementation activities to stabilize areas in zone 1A would result in short-term, moderate, and adverse impacts on the primitive wilderness character and opportunities for solitude. Long-term impacts would be negligible and beneficial. In zones 1B through 4, restoration implementation fieldwork and rerouting of trails would result in localized, short-term, minor to major, adverse impacts on opportunities for solitude or primitive and unconfined recreation. The long-term impacts from restoration would be negligible to minor and beneficial. Cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. This alternative's contribution to these effects would be small.	Implementation of revegetation, bank stabilization, debris and sediment removal, and channel reconfiguration would have short-term, major, adverse impacts on the untrammeled wilderness quality. Over the long term, the rate of hydrologic and vegetative recovery would substantially increase, and ecological and hydrologic processes would improve as a result of restoration activities. This would occur throughout much of the project area, although overall restoration of reference conditions would be less and take longer than in alternatives D and E. Long-term impacts from restoration would be moderate to major and beneficial relative to alternative A. The creation of terraces in zones 2 and 3 would result in short-term, moderate, adverse impacts and long-term, minor, adverse impacts on the untrammeled wilderness quality. During implementation, temporary developments would result in localized, short and long-term, adverse impacts of moderate intensity to the undeveloped wilderness character. During implementation, restoration components would result in short-term, adverse impacts of moderate intensity on the natural wilderness quality. Over the long term, the rate of hydrologic and vegetative recovery would substantially increase, and ecological and hydrologic processes would improve as a result of restoration activities. This would occur throughout much of the project area, although overall restoration of reference conditions would be less and take longer than in alternatives D and E. Long-term impacts on the natural wilderness quality would be moderate to major and beneficial relative to alternative A. Stabilization and restoration implementation fieldwork and the resulting noise, visual presence, and trail and campsite closures would result in localized, short and long-term, moderate to major, adverse impacts on opportunities for solitude or primitive and unconfined recreation. The long-term impacts from restoration would be moderate and beneficial. Cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. This alternative's contribution to these effects would be beneficial.	Implementation of revegetation, bank stabilization, debris removal, and channel reconfiguration would have short-term, major adverse impacts on the untrammeled wilderness quality. Over the long term, the restoration actions would reduce the damage caused by the 2003 breach. The rate of hydrologic and vegetative recovery would also substantially increase, primarily in the alluvial fan in zones 2 and 3 and in the wetland in zones 3 and 4. Overall restoration of reference conditions would be greater and take less time than in alternatives C but would be less than in alternative E. Long-term impacts from restoration would be major and beneficial relative to alternative A. The creation of terraces in zones 2 and 3 would result in short-term, moderate, adverse impacts and long-term, minor, adverse impacts on the untrammeled wilderness quality. During implementation, temporary developments would result in localized, short, and temporary long-term, adverse impacts of moderate intensity to the undeveloped wilderness character. During implementation, restoration components would result in short-term, adverse impacts of moderate intensity on the natural wilderness quality. Over the long term, the rate of hydrologic and vegetative recovery would substantially increase, and ecological and hydrologic processes would improve as a result of restoration activities, primarily in the alluvial fan in zones 2 and 3 and in the wetland in zones 3 and 4. Overall restoration of reference conditions would be greater and take less time than in alternatives C but would be less than in alternative E. Long-term impacts on the natural wilderness quality would be major and beneficial relative to alternative A. The resulting noise, visual presence, and trail and campsite closures from restoration implementation fieldwork would result in localized, short- and temporary long-term, moderate to major, adverse impacts on opportunities for solitude or primitive and unconfined recreation. The long-term impacts from restoration would be moderate and beneficial. Cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. This alternative's contribution to these effects would be beneficial.	Implementation of revegetation, bank stabilization, debris removal, and channel reconfiguration would have short-term, major, adverse impacts on the untrammeled wilderness quality. Over the long term, the restoration actions under alternative E would greatly reduce erosion and restore damages caused by the 2003 breach. The rate of hydrologic and vegetative recovery would also substantially increase due to the large amount of restoration action in zones 2, 3, and 4. Overall restoration of reference conditions would be the greatest and take the least time of all the alternatives. Long-term impacts from restoration would be major and beneficial relative to alternative A. The creation of terraces in zones 2, 3, and 4 would result in short-term, moderate, adverse impacts and long-term, minor, adverse impacts on the untrammeled wilderness quality. During implementation, temporary developments would result in localized, short and long-term, adverse impacts of moderate intensity to the undeveloped wilderness character. Actions and components of restoration during implementation would result in short-term, adverse impacts of moderate intensity on the natural wilderness quality. Over the long term, the rate of hydrologic and vegetative recovery would substantially increase, and ecological and hydrologic processes would be restored due to the large amount of restoration action in zones 2, 3, and 4. Overall restoration of reference conditions would be the greatest and take the least time of all the alternatives. Long-term impacts on the natural wilderness quality would be major and beneficial relative to alternative A. The resulting noise, visual presence, and trail and campsite closures from restoration implementation fieldwork would result in localized, short- and long-term, moderate to major, adverse impacts on opportunities for solitude or primitive and unconfined recreation. The long-term impacts from restoration would be moderate and beneficial. Cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. This alternative's contribution to these effects would be beneficial.

Table 2.8: Summary of Environmental Consequences (Continued)

Impact Topic	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Natural Soundscape	No restoration management actions would occur and therefore impacts on the natural soundscape would be negligible. Impacts on the natural soundscape from the permitted use of backcountry campsites would be short-term and negligible to minor and adverse depending on the time on the time of year and location. The cumulative effects on the natural soundscape would continue to be short term, local and regional, moderate, and adverse. The actions associated with alternative A would have a small contribution to the cumulative impacts on natural soundscape.	Impacts from the use of heavy machinery to implement option 1 or 2 in zone 1A would be short-term, major, and adverse. Effects on the natural soundscape from the use of a helicopter to fly machinery and supplies in and out of the project area at the start and end of restoration activities would be short-term, major, and adverse. The sounds emitted by equipment would be audible frequently throughout the day up to 4 miles from the source. When no equipment is operating in zone 1A, the use of hand tools in zones 1B and 2, where the ambient noise level is higher, would result in localized, short-term, minor, adverse impacts. Within zones 3 and 4, where the ambient noise levels are lower, adverse impacts on the natural soundscape would be localized, short-term, and minor to moderate depending on the tools and restoration activity. The sounds emitted by hand tools or chainsaws would be audible either occasionally, as with chainsaws, or less than 1,640 feet from the source, as with hand tools. Human activity and the emergency nighttime use of a generator permitted for emergencies in both temporary line camps established in the project area would have short-term, adverse impacts of major intensity on the natural soundscape because noise would be audible up to 1.4 miles during sensitive times of the day. Temporary closure of the backcountry campsites would result in a negligible beneficial impact on the natural soundscape. The cumulative effects on the natural soundscape would continue to be short term, local and regional, major, and adverse. The actions associated with alternative B would make a modest contribution to the cumulative impacts on natural soundscape.	Impacts from the use of heavy machinery to implement option 1 or 2 in zone 1A and restoration activities in zones 1B through 4 would be short-term, major, and adverse. Effects on the natural soundscape from the use of a helicopter to fly machinery and supplies in and out of the project area would be short-term, major, and adverse depending on the distance from the helicopter. Restoration work may take place in all zones simultaneously, or may be concentrated in one area. The sounds emitted by equipment would be audible frequently throughout the day up to 4 miles from the source. Emergency nighttime use of a generator permitted for emergencies in both temporary line camps established in the project area would have short-term, adverse impacts of major intensity on the natural soundscape. Impacts from the temporary closure of the backcountry campsites would result in a slight beneficial impact on natural soundscapes, because noise would be audible up to 1.4 miles during sensitive times of the day. Tall willow established in wetland would create a buffer from human-caused noise generated outside the wetland and would result in a local, long-term, negligible to minor, beneficial effect. The cumulative effects on the natural soundscape would continue to be short term, local and regional, major, and adverse. The actions associated with alternative C would have a substantial contribution to the cumulative impacts on natural soundscape.	Impacts from the use of heavy machinery to implement option 1 or 2 in zone 1A and restoration activities in zones 1B through 4 would be short term, major, and adverse. Effects on the natural soundscape from the use of a helicopter to fly machinery and supplies in and out of the project area would be short term, major, and adverse, depending on the distance from the helicopter. Restoration work would most likely take place simultaneously throughout zone 1B through 4. The sounds emitted by equipment would be audible frequently throughout the day up to 4 miles from the source. Emergency nighttime use of a generator permitted for emergencies in both temporary line camps established in the project area would have short-term, adverse impacts of major intensity on the natural soundscape. Temporary closure of the backcountry campsites would result in a slight beneficial impact on natural soundscapes, because less noise would be audible up to 1.4 miles during sensitive times of the day. Tall willow established in wetland would create a buffer from human-caused noise generated outside the wetland and would result in a local, long-term, negligible to minor, beneficial effect. Cumulative impacts on the natural soundscape would continue to be major, short term, local and regional, and adverse. This alternative's contribution to these effects would be substantial and adverse.	Impacts from the use of heavy machinery to implement option 1 or 2 in zone 1A and restoration activities in zones 1B through 4 would be short term, major, and adverse. Effects on the natural soundscape from the use of a helicopter to fly machinery and supplies in and out of the project area would be short-term, major, and adverse, depending on the distance from the helicopter. Restoration work would take place simultaneously throughout zone 1B. The sounds emitted by equipment would be audible frequently throughout the day up to 4 miles from the source. Emergency nighttime use of a generator permitted for emergencies in both temporary line camps established in the project area would have short-term, adverse impacts of major intensity on the natural soundscape. Temporary closure of the backcountry campsites would have a slight beneficial impact on natural soundscapes because noise would be audible up to 1.4 miles during sensitive times of the day. Tall willow established in wetland would create a buffer from human-caused noise generated outside the wetland and would result in a local, long-term, negligible to minor, beneficial effect. The cumulative effects on the natural soundscape would continue to be short term, local and regional, major, and adverse. The actions associated with alternative E would have a substantial contribution to the cumulative impacts on natural soundscape.
Geology and Soils	Impacts would be long-term, local, moderate, and adverse. Adverse impacts would result from continued degradation of areas eroded during the 2003 breach, and the continued existence of large areas of deposition. The cumulative effect of alternative A and other plans and projects would be long-term, local, moderate, and adverse, with alternative A contributing substantially to the overall adverse effect. The actions associated with alternative A would have a substantial contribution to these cumulative impacts.	Impacts would be long-term, local, moderate, and adverse. Adverse impacts on soils buried under large areas of deposition would remain, as would adverse impacts from continued, but more limited, erosion and deposition in the project area. Minor long-term benefits would result from efforts to stabilize and revegetate areas of erosion and deposition. The cumulative effect of alternative B and other plans and projects would be long term, local, moderate, and adverse. The actions associated with alternative B would have a substantial contribution to these cumulative impacts.	Impacts would be long-term, local, minor to moderate, and beneficial. Benefits would result from recontouring impacted areas, removing deposits, and stabilizing and revegetating within the project area. Most adverse impacts are short-term and should respond well to mitigation. The cumulative effect of alternative C and other plans and projects would be long-term, local, minor to moderate, and beneficial. The actions associated with alternative C would have a substantial contribution to these cumulative impacts.	Impacts would be long-term, local, major, and beneficial. Benefits would result from localized recontouring impacted areas, removing large debris deposits, and stabilizing and revegetating within the project area. Most adverse impacts are short-term and should respond well to mitigation. The cumulative effect of alternative D and other plans and projects would be long-term, local, major, and beneficial. The actions associated with alternative D would have a substantial contribution to these cumulative impacts.	Impacts would be long-term, local, major, and beneficial. Benefits would result from widespread recontouring and filling in impacted areas, removing large debris deposits, and extensive stabilizing and revegetating within the project area. Most adverse impacts are short-term and should respond well to mitigation. The cumulative effect of alternative E and other plans and projects would long-term, local, major, and beneficial. The actions associated with alternative E would have a substantial contribution to these cumulative impacts.

Table 2.8: Summary of Environmental Consequences (Continued)

Impact Topic	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Water Resources	There would be major, adverse impacts on water quality because the increases in some water quality constituents during peak runoff periods would likely occur outside the normal range of variability. This alternative would have major adverse impacts on surface water hydrology and stream channel morphology in Lulu Creek, the Colorado River, and the Lulu City wetland. The Lulu City wetland would continue to provide a beneficial sediment retention water quality function. Insufficient groundwater hydrology information is available to determine impacts on groundwater in the Lulu City wetland. Changes in stream channel morphology caused by annual debris accumulation and erosion in the river channel combined with channel flow reductions caused by Grand Ditch diversions contribute to a major adverse cumulative effect on Colorado River channel stability below the Lulu Creek confluence. Annual debris deposits in the Lulu City wetland cause major adverse cumulative effects on wetland surface water hydrology and stream channel morphology. Some wetland water quality treatment functions would be decreased by accumulated sediment deposits in the Lulu City wetland.	Short-term, adverse water quality changes resulting from restoration measures would be minor, and none of the regulated water quality constituents would exceed water quality standards. Restoration measures would produce long term beneficial water quality impacts. Long-term, major adverse impacts on surface water hydrology and stream channel morphology would continue. These same streamflow and stream channel morphology conditions would contribute to long-term, adverse, cumulative impacts in Lulu Creek, the Colorado River, and the Lulu City wetland. The Lulu City wetland would continue to provide long term, beneficial sediment and nutrient filtering and retention water quality functions. However, some wetland water quality treatment functions would remain reduced because accumulated sediment deposits in the Lulu City wetland would reduce sediment retention capacity.	Short-term, adverse water quality changes resulting from restoration measures would be major because nitrate-nitrogen concentrations, a regulated water quality constituent, would exceed water quality standards. During construction, short-term, major, adverse impacts and major, long-term, adverse water quality impacts after construction may result from conflict with the antidegradation requirement of the Outstanding Waters standard. Following restoration, the actions would result in long-term, beneficial water quality improvements by removing much of the suspended sediment and sediment sources. Lulu Creek and Colorado River channel restoration would result in long-term beneficial effects on surface hydrology and stream channel morphology. Major short-term adverse impacts on hydrology and stream channel morphology would occur in Lulu Creek, the Colorado River, and the Lulu City wetland during restoration periods. Lulu City wetland may provide reduced long term, beneficial sediment and nutrient filtering and retention water quality functions because of surface water hydrologic changes. Some streamside sediment removal from the river floodplain in area M of zone 3 would also restore former spring floodflow retention and discharge by wetlands that are currently partially prevented from providing this beneficial floodplain function. This would be a long-term, moderate, beneficial impact.	Short-term, adverse water quality changes resulting from implementation of the restoration measures would be major because nitrate-nitrogen concentrations, a regulated water quality constituent, would exceed water quality standards. Short-term, major, adverse impacts during construction and major, long-term, adverse water quality impacts after construction may result from conflict with the antidegradation requirement of the Outstanding Waters standard. Restoration actions would result in long-term, moderate, beneficial water quality improvements by removing some of the suspended sediment and sediment sources. The Lulu City wetland may provide reduced long term, beneficial sediment and nutrient filtering and retention water quality functions because of surface water hydrologic changes that direct more surface water flow to the central river channel and less sheetflow to other parts of the wetland. Lulu Creek and Colorado River channel restoration would result in long-term beneficial effects on surface hydrology and stream channel morphology. Major short-term adverse impacts on hydrology and stream channel morphology would occur in Lulu Creek, the Colorado River, and the Lulu City wetland during the sediment removal periods. The same long-term, moderate, beneficial floodplain floodwater retention and discharge functions described for alternative C would occur for alternative D in area M of zone 3.	Short-term, adverse water quality changes resulting from restoration measures would be major because nitrate-nitrogen concentrations, a regulated water quality constituent, would exceed water quality standards. Short-term, major, adverse impacts during construction and major, long-term, adverse water quality impacts for several years after construction may result from conflict with the antidegradation requirement of the Outstanding Waters standard. After restoration actions were completed, moderate, long-term, beneficial water quality improvements would result from removing much of the suspended sediment and debris sources. The Lulu City wetland may provide reduced long term, beneficial sediment and nutrient filtering and retention water quality functions because of surface water hydrologic changes that direct more surface water flow to the central river channel and less sheetflow to other parts of the wetland. Lulu Creek and Colorado River channel restoration would result in long-term beneficial effects on surface hydrology and stream channel morphology. Major short-term adverse impacts on hydrology and stream channel morphology would occur in Lulu Creek, the Colorado River, and the Lulu City wetland during restoration periods. Extensive streamside sediment removal from the river floodplain in area M of zone 3 would also restore former spring floodflow retention and discharge by wetlands that are currently partially prevented from providing this beneficial floodplain function. This would be a long-term, moderate, beneficial impact.
Wetlands	Long-term, local moderate to major adverse effects on wetlands because continued buried wetland vegetation would no longer attenuate floodflows as effectively as before the breach, reduce overall vegetated wetland area, reduce wetland diversity with a lower potential to provide habitat for terrestrial and aquatic species, and alter groundwater table characteristics because of sediment deposits. The minor benefits associated with the regeneration of willow and sedge wetlands under no action are limited in their ability to provide wetland functions and are outweighed by the adverse impacts described above. The cumulative impacts of alternative A combined with the impacts of past, present, and reasonably foreseeable actions would continue to be long term, moderate, and adverse. Alternative A's contribution to the overall cumulative effect would be large.	Long-term, local, minor, beneficial effects on wetlands would result from stabilizing sediment and increasing wetland plant biomass. Restoration activities would have a short-term, moderate, adverse impact on about 0.8 acre of wetland, stream channel, and associated riparian areas. The local, minor, beneficial effects of alternative B on wetlands would contribute cumulatively to the effects of past, present, and reasonable foreseeable actions, which would continue to be long term, moderate, and adverse. Alternative B would provide a small beneficial contribution to the cumulative impacts.	Long-term, local, major, beneficial effects on wetlands would result from removing sediment from the Lulu City wetland, planting tall willows to increase habitat and species diversity, protecting willow with temporary browsing exclosure fences, restoring historical hydrologic conditions as a result of sediment removal and rerouting the Colorado River to its historical channel through the Lulu City wetland, and providing a more diverse wetland community. Restoration activities would have a short-term, major, adverse impact on about 18.8 acres of wetland, stream channel, and associated riparian areas. The cumulative effects of all the other plans and projects on wetlands would be long term and, on balance, likely neutral, because the adverse effects of the Grand Ditch operations would be offset by the benefits for wetlands represented by alternative C. Alternative C would contribute substantially to a long-term, beneficial, cumulative effect on wetlands.	Long-term, local, major, beneficial effects on wetlands would result from removing sediment from the Lulu City wetland, establishing a tall willow community with other wetland plant species to increase habitat and species diversity, protecting willow with temporary browsing exclosure fences, restoring historical hydrologic conditions as a result of sediment removal and rerouting the Colorado River to its historical channel through the Lulu City wetland, and increasing the potential for the enhancement of wetland functions. Restoration activities would have a short-term, major, adverse impact on about 8.7 acres of wetland, stream channel, and associated riparian areas. The cumulative effects of all the other plans and projects on wetlands would be long term and, on balance, likely neutral, as the adverse effects of the Grand Ditch operations would be offset by the substantial benefits for wetlands represented by alternative D. Alternative D would contribute substantially to a long-term, beneficial cumulative effect on wetlands.	Long-term, local, major, beneficial effects on wetlands would result from removing sediment from the Lulu City wetland, establishing a tall willow community with other wetland plant species to increase habitat and species diversity, protecting willow with temporary browsing exclosure fences, restoring historical hydrologic conditions as a result of sediment removal and rerouting the Colorado River to its historical channel through the Lulu City wetland, and increasing the potential for the enhancement of wetland functions. Restoration activities would have a short-term, major, adverse impact on about 21.4 acres of wetland, stream channel, and associated riparian areas. The cumulative effects of all other plans and projects on wetlands would be long term and, on balance, likely neutral, because the adverse effects of the Grand Ditch operations would be offset by the substantial benefits for wetlands represented by alternative E. Alternative E would contribute substantially to a long-term, beneficial, cumulative effect on wetlands.

Table 2.8: Summary of Environmental Consequences (Continued)

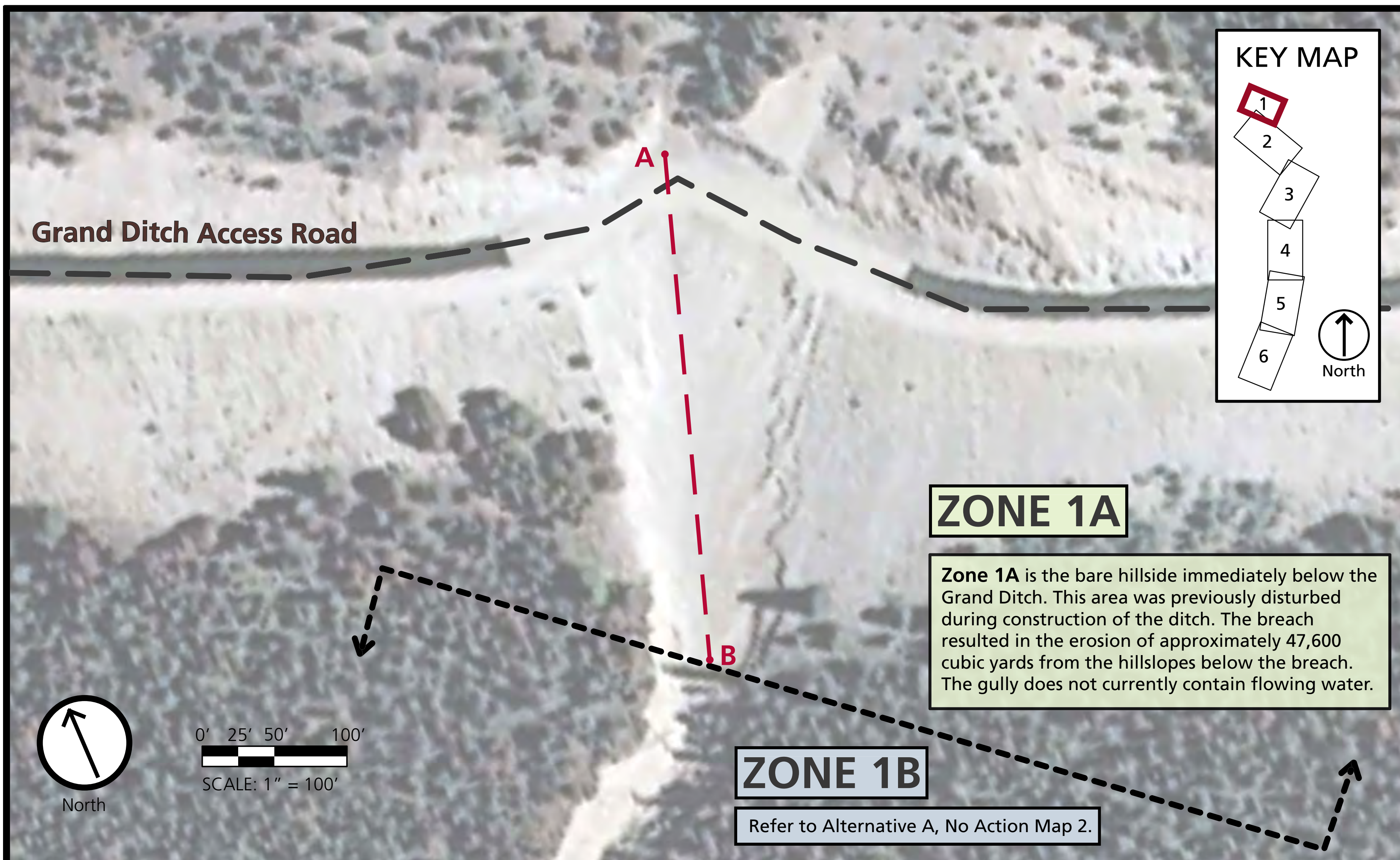
Impact Topic	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Vegetation	Long-term, local minor to major adverse effects on vegetation would result because of continued upstream erosion, rapidly shifting stream channels, bank instability, and sediment deposition. The benefits associated with regeneration or persistence of vegetation under no action are limited to relatively small areas and are outweighed by the adverse impacts described above. Alternative A would contribute a modest amount to the overall long-term cumulative adverse effects on vegetation because the effects of no action on vegetation are more pronounced than the combined cumulative benefits of other management plans.	Long-term, local, minor beneficial effects on vegetation would result in direct proportion to the minimal degree of restoration actions that are associated with this alternative. The minor beneficial effects of past, present, and foreseeable future actions would combine with the minor beneficial effects of alternative B to result in long-term, local, minor, cumulative beneficial effects on vegetation. Alternative B's contribution to these effects would be modest.	Long-term, local, major, beneficial effects on vegetation would result in direct proportion to the degree of restoration actions that are associated with this alternative. The short-term, local adverse effects on upland vegetation lost during development of debris storage terraces would be outweighed by the eventual establishment of upland vegetation on the terraces This relationship is based on the actions to control erosion, replant upland, riparian, and wetland vegetation, remove sediment and debris, and install temporary browsing exclosure fences to protect new plantings. The benefits associated with alternative C would be incrementally greater than alternative B because of its added restoration actions. The beneficial cumulative effects of past, present, and foreseeable future actions would combine with the major beneficial effects of alternative C to result in long-term, local, major, cumulative beneficial effects on vegetation. Alternative C's contribution to these effects would be substantial.	Long-term, local, major, beneficial effects on vegetation would result directly proportional to the degree of restoration actions that are associated with this alternative. This relationship is based on the actions to control erosion, replant upland, riparian, and wetland vegetation, remove sediment and debris, and install temporary browsing exclosure fences to protect new plantings. The benefits associated with alternative D would be incrementally greater than alternatives B because of its additional restoration actions. The beneficial cumulative effects of past, present, and foreseeable future actions would combine with the major, beneficial effects of alternative D to result in long-term, local, major, cumulative, beneficial effects on vegetation. Alternative D's contribution to these effects would be substantial.	Long-term, local, major, beneficial effect on vegetation would result in a direct relationship proportional to the degree of restoration actions that are associated with this alternative. This relationship is based on the actions to control erosion, replant upland, riparian, and wetland vegetation, remove sediment and debris, and install temporary browsing exclosure fences to protect new plantings. The benefits associated with alternative E would be incrementally greater than alternatives C and D because of its additional restoration actions. The beneficial cumulative effects of past, present, and foreseeable future actions would combine with the major, beneficial effects of alternative E to result in long-term, local, major, cumulative, beneficial effects on vegetation. Alternative E's contribution to these effects would be substantial.
Special Status Species	The continued management of the project area would result in long-term, local, minor adverse effects on the boreal toad and wood frog, and negligible to minor long-term adverse effects on the Colorado River cutthroat trout because these species rely on these habitats locally. Under alternative A, there would be no impacts on the river otter, Canada lynx, or wolverine because their habitats and ranges are widespread and the project area represents only a small portion of their range. These impacts combined with past, present, and future projects would result in cumulative impacts that would be long-term and moderate for the boreal toad, wood frog, Colorado River cutthroat trout, river otter, Canada lynx, and wolverine. The contribution of alternative A to adverse cumulative impacts would not be substantial.	The presence of work crews in the project area and the restoration actions conducted would have local, short-term, and negligible to minor adverse impacts on all special status species, including the Colorado River cutthroat trout. The actions of the alternative would create a disturbance and serve as a deterrent to these species using the area; however, these effects would only occur during the restoration work. Both the boreal toad and the wood frog would experience long-term minor benefits as a result of the reduction of sediment and debris flowing into Lulu City. Additionally, revegetation and restoration of riparian and wetland habitats throughout the project would benefit these species. The removal of sediment and debris from the Colorado River and the stabilization of its banks would have a negligible to minor benefit for the Colorado River cutthroat trout and river otter over the long term by improving water quality and habitat. Because the project area only represents a limited portion of the trout's habitat, impacts from the project would be primarily felt by the local population of Colorado River cutthroat trout. The actions of alternative B would not significantly alter lynx or wolverine habitat in the breach area. The cumulative effects from alternative B and past, present, and future projects would be long-term, moderate, and beneficial.	The presence of work crews in the project area and the restoration actions conducted would have local, short-term, and negligible to moderate adverse impacts on special status species. The actions of the alternative would create a disturbance and serve as a deterrent to use of the area. However, these effects would only occur for the duration of the work, a period of two to three seasons. Comprehensive water resource mitigation measures would be deployed to avoid and minimize adverse effects to the Colorado River cutthroat trout and other aquatic species. The restoration actions would have long-term, moderate to major benefits for the boreal toad and wood frog; minor to moderate benefits for cutthroat trout; and negligible to minor benefits for river otter, Canada lynx, and wolverines in the area. The restoration of the Lulu City wetland and the reestablishment of the Colorado River into its historical channel would help to restore hydrologic conditions to the project area, largely benefiting habitat of the boreal toad and wood frog. Slope stabilization and revegetation throughout the project area would improve water quality and riparian habitats, and extensive willow revegetation would help to establish historical habitat conditions. This would improve habitat for the cutthroat trout and river otter. Overall, these actions would help restore habitat complexity, species diversity, and forage opportunities for lynx and wolverine. Combined with past, present, and future projects, the cumulative impacts of alternative C would be long-term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and wildlife habitat in the project area.	The presence of work crews in the project area and the restoration actions conducted would have local, short-term, and negligible to moderate adverse impacts on special status species. The actions would create a disturbance and serve as a deterrent to use of the area. This disturbance would be greater than under alternative B because this alternative would utilize large, mechanized equipment which would generate more noise over a larger footprint. However, these effects would only be felt during the duration of the work, a period of two to three seasons. Similar to alternative C, comprehensive water resource mitigation measures would be deployed to avoid and minimize adverse effects to the Colorado River cutthroat trout and other aquatic species. Measures would be deployed and scaled proportionally to the areas disturbed by restoration activities. Similar to alternative C, the restoration actions would have long-term, moderate to major benefits for the boreal toad and wood frog; moderate benefits for cutthroat trout; and negligible to minor benefits for river otter, Canada lynx, and wolverines in the area. The restoration of the Lulu City wetland and the reestablishment of the Colorado River into its historical channel would help restore hydrologic conditions, benefiting habitat of the boreal toad and wood frog. Slope stabilization, revegetation throughout the project area, and removal of debris from the alluvial fan in zone 2 would improve water quality and riparian habitats, and extensive willow revegetation would help establish historical habitat conditions. This would improve habitat for the cutthroat trout and river otter. Overall, these actions would help restore habitat complexity, species diversity, and forage opportunities for lynx and wolverine.	The presence of work crews in the project area and the restoration actions conducted would have local, short-term, and negligible to moderate adverse impacts on special status species. The actions would create a disturbance and serve as a deterrent to use of the area. This disturbance would be greater than under alternatives C and D because this alternative would utilize a staging/haul road which would result in a larger footprint. However, these effects would only be felt during the duration of the work, a period of two to three seasons. Similar to alternatives C and D, comprehensive water resource mitigation measures would be deployed to avoid and minimize adverse effects to the Colorado River cutthroat trout and other aquatic species. Measures would be deployed and scaled proportionally to the areas disturbed by restoration activities. Similar to alternatives C and D, the restoration actions under alternative E would have long-term, moderate to major benefits for the boreal toad and wood frog; moderate benefits for cutthroat trout; and negligible to minor benefits for river otter, Canada lynx, and wolverines in the area. The restoration of the Lulu City wetland and the reestablishment of the Colorado River into its historical channel would help to restore hydrologic conditions to the project area, benefiting habitat of the boreal toad and wood frog. Slope stabilization and revegetation throughout the project area would improve water quality and riparian habitats, and extensive willow revegetation would help to establish historical habitat conditions. This would improve habitat for the cutthroat trout and river otter. Overall, these actions would help restore habitat complexity, species diversity, and forage opportunities for lynx and wolverine.

Table 2.8: Summary of Environmental Consequences (Continued)

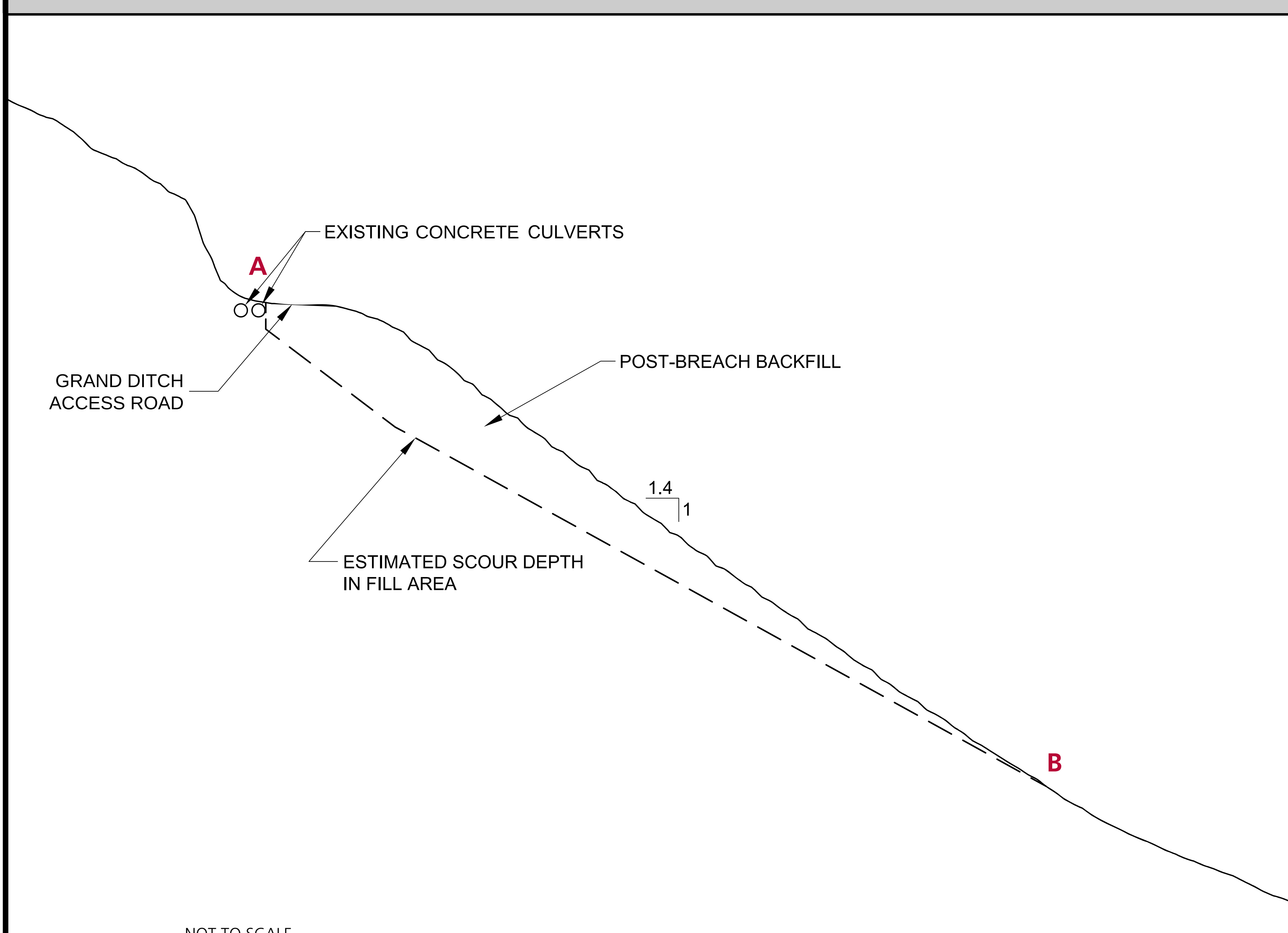
Impact Topic	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Special Status Species (continued)				Combined with past, present, and future projects, the cumulative impacts of alternative D would be long-term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and wildlife habitat in the project area.	Combined with past, present, and future projects, the cumulative impacts of alternative E would be long-term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and wildlife habitat in the project area.
Wildlife	The continued management of the project area would have a number of adverse impacts on wildlife in the Upper Kawuneeche Valley. The adverse impacts would be primarily local, long-term, and range from negligible to moderate intensity. Given the current hydrologic condition of the project area, remaining debris deposits in Lulu Creek, the Lulu Creek alluvial fan, and the Colorado River corridor are susceptible to high flow events that increase sedimentation and turbidity, deposit debris, and scour the riparian corridor. The following effects on wildlife are anticipated under this alternative. Beavers in the project area would suffer local, long-term, and moderate adverse effects from the loss of willow and wetland habitats in the breach area. There would be no impact on the ungulate species that occur in the project area. The impacts on birds would vary by species from negligible to moderate adverse, but all impacts would be local and long-term. Songbirds would be expected to suffer more from the habitat loss and degradation than birds of prey. Impacts on small- to medium-sized mammals would be local, long-term, minor, and adverse. There would be no impact on predators and scavengers under alternative A. The loss of wetland habitats anticipated under this alternative would result in minor adverse impacts on amphibians and reptiles. Fish would experience local, long-term, and negligible to minor adverse effects from continuation of current conditions. The loss of wetland habitats and habitat diversity would result in local, long-term, minor to moderate adverse effects on terrestrial invertebrates and short-term, minor to moderate impacts on aquatic invertebrates. Overall, the cumulative impacts on wildlife from alternative A and past, present, and future projects would be long term, moderate, and beneficial. While local pressures resulting from the 2003 Grand Ditch breach and the subsequent habitat degradation would continue to occur, the benefits of other large-scale projects and plans to conserve habitat and protect wildlife would outweigh these localized adverse effects.	The presence of work crews in the project area and the restoration actions conducted would have local, short-term, and negligible to minor adverse impacts on wildlife. The actions of the alternative would create a disturbance and serve as a deterrent to wildlife using the area; however, these effects would only be felt during the duration of the work. Similar to alternative A, the restoration work under this alternative would address little wetland and hydrologic degradation, which would long-term and range from negligible to moderate adverse impacts on fish and wildlife. Long-term, negligible to minor benefits to wildlife from alternative B would result from restoration of upland and riparian habitats, and aquatic habitats would benefit from slope stabilization and revegetation that would contribute to improved water quality. The wildlife groups that would experience the most benefits under this alternative are small- to medium-sized mammals (including beaver), fish, and amphibians and reptiles. The cumulative effects from alternative B and past, present, and future projects would be long term, moderate, and beneficial. The contribution of alternative B would be small.	The presence of work crews in the project area and the restoration actions using large, mechanized equipment which would generate more noise over a large footprint would have local, short-term, and negligible to major adverse impacts on wildlife. However, these effects would only occur during restoration activities, a period of two to three seasons. <u>Comprehensive water resource mitigation measures would be deployed to avoid and minimize adverse effects to trout and other aquatic species.</u> The restoration actions under alternative C would have long-term, local, minor to major benefits for wetland and riparian-associated wildlife species in the area, including beaver. Overall, these actions would help restore habitat complexity, species diversity, and forage opportunities for a number of species. Combined with past, present, and future projects, the impacts of alternative C would be long-term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and wildlife habitat.	The presence of work crews in the project area and the restoration actions conducted would have local, short-term, and negligible to major adverse impacts on wildlife. The actions of the alternative would create a disturbance and serve as a deterrent to wildlife using the area as a result of mechanized equipment and helicopters which would generate more noise over a large footprint. However, these effects would only occur during the restoration actions, a period of two to three seasons. <u>Similar to alternative C, comprehensive water resource mitigation measures would be deployed to avoid and minimize adverse effects to trout and other aquatic species. Measures would be deployed and scaled proportionally to the areas disturbed by restoration activities.</u> The restoration actions under alternative D would have local, long-term, minor to major benefits for wetland and riparian-associated wildlife species in the area, including beaver. The restoration of the Lulu City wetland and the reestablishment of the Colorado River into its historical channel would help to restore hydrologic conditions to the project area. Streambank stabilization, removal of large sediment and debris deposits, and revegetation throughout the project area would improve water quality and riparian habitats, and extensive willow revegetation would help to establish historical habitat conditions. Overall, these actions would help restore habitat complexity, species diversity, and forage opportunities for a number of species. The cumulative effects from alternative D and from past, present, and future projects would be long-term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and wildlife habitat.	The presence of work crews in the project area and the restoration actions using large, mechanized equipment which would generate more noise over a larger footprint under alternative E would have local, short-term, and negligible to major adverse impacts on wildlife. The development of a staging/haul road to transport material and equipment under this alternative would create more pronounced adverse effects. <u>Similar to alternatives C and D, comprehensive water resource mitigation measures would be deployed to avoid and minimize adverse effects to trout and other aquatic species. Measures would be deployed and scaled proportionally to the areas disturbed by restoration activities.</u> The restoration actions under alternative E would have long-term, minor to major, benefits for wetland and riparian-associated wildlife species in the area, including beaver. The restoration of the Lulu City wetland and the reestablishment of the Colorado River into its historical channel would help to restore hydrologic conditions to the project area. Streambank stabilization and revegetation throughout the project area would improve water quality and riparian habitats, and extensive willow revegetation would help to establish historical habitat conditions. Alternative E would create better conditions for willow health than alternatives C and D due to the removal of an increased of amount of debris and sediment and its subsequent deposition in riparian zones. Overall, these actions would help restore habitat complexity, species diversity, and forage opportunities for a number of species. The cumulative effects from alternative E and from past, present, and future projects would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and wildlife habitat.

Table 2.8: Summary of Environmental Consequences (Continued)

Impact Topic	Alternative A – No Action / Continue Current Management	Alternative B – Minimal Restoration	Alternative C – High Restoration	Alternative D – NPS Preferred Alternative	Alternative E – Maximum Restoration
Cultural Resources	**Archeological Resources.** Alternative A contains no ground disturbing activities; therefore, there is no potential to encounter archeological resources under this alternative. Alternative A would have a long-term, negligible impact on archeological resources. Therefore, it would not measurably add to or detract from the existing long-term, minor, adverse cumulative impacts, resulting in overall long-term, minor, adverse cumulative impacts. **Historic Structures.** Alternative A includes no specific actions that would lead to changes to the park's historic structures, resulting in a long-term, negligible impact on the historic structure found within the project area. There would be no cumulative impacts on historic structures under this alternative.	**Archeological Resources.** Alternative B includes restoration activities that are unlikely to disturb archeological resources. Mitigation actions would ensure that any impacts resulting from disturbance from restoration activities under this alternative would be long term, negligible to minor, and adverse. Therefore, it would incrementally add to the existing long-term, minor, adverse cumulative impacts, resulting in overall long-term, minor, adverse cumulative impacts. **Historic Structures.** Alternative B includes elements that would lead to both long-term, minor, adverse impacts, as well as long-term, moderate, beneficial impacts, combining to result in long-term, moderate, beneficial impacts on the historic structure found within the project area due to the preservation of its linear entirety. There would be no cumulative impacts on historic structures under this alternative.	**Archeological Resources.** Alternative C includes restoration activities that are unlikely to disturb archeological resources. Mitigation actions would ensure that any impacts resulting from disturbance by restoration activities under this alternative would be long term, negligible to minor, and adverse. Therefore, it would incrementally add to the existing long-term, minor, adverse cumulative impacts, resulting in overall long-term, minor, adverse cumulative impacts. **Historic Structures.** Alternative C includes elements that would lead to both long-term, minor, adverse impacts, as well as long-term beneficial impacts, combining to result in long-term, moderate, beneficial impacts on the historic structure found within the project area due to the stabilization provided to the Grand Ditch. There would be no cumulative impacts on historic structures under this alternative.	**Archeological Resources.** Alternative D includes restoration activities that are unlikely to disturb archeological resources. Mitigation actions would ensure that any impacts resulting from disturbance by restoration activities under this alternative would be long-term, negligible to minor, and adverse. Therefore, it would incrementally add to the existing long-term, minor, adverse cumulative impacts, resulting in overall long-term, minor, adverse cumulative impacts. **Historic Structures.** Alternative D includes elements that would lead to both long-term, minor, adverse impacts, as well as long-term beneficial impacts, combining to result in long-term, moderate, beneficial impacts on the historic structure found within the project area due to the stabilization provided to the Grand Ditch. There would be no cumulative impacts on historic structures under this alternative.	**Archeological Resources.** Alternative E includes restoration activities that are unlikely to disturb archeological resources. Mitigation actions would ensure that any impacts resulting from disturbance by restoration activities under this alternative would be long—term, negligible to minor, and adverse. Therefore, it would incrementally add to the existing long-term, minor, adverse cumulative impacts, resulting in overall long-term, minor, adverse cumulative impacts. **Historic Structures.** Alternative E includes elements that would lead to both long-term, minor, adverse impacts, as well as long-term beneficial impacts, combining to result in long-term, moderate, beneficial impacts on the historic structure found within the project area due to the stabilization provided to the Grand Ditch. There would be no cumulative impacts on historic structures under this alternative.
Visitor Use and Experience	Impacts on visitor use and experience from intrusions to the natural soundscape would be negligible to minor and adverse depending on the time on the time of year and location. Impacts on visitor use and experience from the continued visual evidence of damages from the breach would be long-term, minor to moderate, and adverse. Access provided by the numerous trails and campsites within the Kawuneeche Valley would continue to result in long-term, moderate, beneficial impacts. Cumulative impacts on visitor use and experience would continue to be long-term, minor, and adverse. This alternative's contribution to these effects would be modest.	Short-term impacts on visitor use and experience from the visual presence of equipment and crews and intrusions to the natural soundscape from stabilization of zone 1A by option 1 or 2 would be moderate and adverse. Long-term impacts would be negligible and beneficial. Short-term impacts on visitor use and experience from restoration in zones 1B through 4 would be negligible to minor and adverse during implementation. Long-term impacts from revegetation and the improved aesthetic experience would be negligible and beneficial. Temporary closures to backcountry campsites and portions of the Grand Ditch, Colorado River, and Thunder Pass Trails within close proximity to the project area would have short-term adverse impacts of negligible to moderate intensity depending on the trail and location. Cumulative impacts on visitor use and experience would continue to be long-term, minor, and adverse. This alternative's contribution to these effects would be modest and adverse.	Short-term impacts on visitor use and experience from the visual presence of equipment and crews and intrusions to the natural soundscape from stabilization of zone 1A by option 1 or 2 would be moderate and adverse. Long-term impacts would be moderate and beneficial. Short-term impacts on visitor use and experience from intrusions to the natural soundscape from restoration implementation fieldwork in zones 1B through 4 would be minor to major, and adverse depending on the visitor's distance from the project area. The visual presence of equipment, crews, temporary browsing exclosure fences, and debris terraces would be short and long term, moderate to major, and adverse. Long-term impacts from a reduction in the visual evidence of the 2003 breach would be minor and beneficial. Temporary closures to the trails and backcountry campsites within and adjacent to the project area would have short-term adverse impacts of minor to moderate intensity depending on the trail and location. Cumulative impacts on visitor use and experience would continue to be long-term, minor, and adverse. This alternative's contribution to these effects would be modest and adverse over the short term and modest and beneficial over the long term.	Short-term impacts on visitor use and experience from the visual presence of equipment and crews and intrusions to the natural soundscape from stabilization of zone 1A by option 1 would be moderate and adverse. Long-term impacts would be moderate and beneficial. Short-term impacts on visitor use and experience from intrusions to the natural soundscape from restoration implementation fieldwork would be minor to major, and adverse depending on the visitor's distance from the project area. The visual presence of equipment, crews, temporary browsing exclosure fences, and debris terraces would be short and long term, moderate to major, and adverse. Long-term impacts from a reduction in the visual evidence of the 2003 breach would be moderate and beneficial. Temporary closures to the trails and backcountry campsites within and adjacent to the project area would have short-term adverse impacts of minor to moderate intensity depending on the trail and location. Cumulative impacts on visitor use and experience would continue to be long-term, minor, and adverse. This alternative's contribution to these effects would be modest and adverse over the short term and modest and beneficial over the long term.	Short-term impacts on visitor use and experience from the visual presence of equipment and crews and intrusions to the natural soundscape from stabilization of zone 1A by option 1 or 2 would be moderate and adverse. Long-term impacts would be moderate and beneficial. Short-term impacts on visitor use and experience from intrusions to the natural soundscape from restoration implementation fieldwork would be minor to major, and adverse depending on the visitor's distance from the project area. The visual presence of equipment, crews, temporary browsing exclosure fences, and debris terraces would be short and long term, moderate to major, and adverse. Long-term impacts from a reduction in the visual evidence of the 2003 breach would be moderate and beneficial. Temporary closures to the trails and the backcountry campsites within and adjacent to the project area would have short-term adverse impacts of moderate intensity. Cumulative impacts on visitor use and experience would continue to be long-term, minor, and adverse. This alternative's contribution to these effects would be modest and adverse over the short term and modest and beneficial over the long term.
Park Operations	There would be little or no noticeable effect on park operations. On-going management of research activities associated with the effects of the Grand Ditch breach would result in long-term, negligible adverse impacts. Cumulatively, Alternative A, with the other projects and actions, would have long-term, minor to moderate, adverse effects on park operations. Alternative A's contribution to cumulative impacts would be small.	Long-term, negligible, adverse impacts would result from hiring and managing work crews and from monitoring and evaluating the performance of restoration actions, and in long-term, minor, adverse effects on park operations from managing contractors carrying out restoration actions. Alternative B would make a modest, short-term adverse contribution to overall long-term, minor to moderate, adverse cumulative impacts on park operations.	Long-term, negligible to minor, adverse impacts would result from managing visitors, providing information about the restoration activities, and monitoring and evaluating the performance of restoration actions. Long-term, minor to moderate, adverse impacts would result from managing contractors performing restoration actions. Alternative B would make a modest adverse contribution to overall long-term, minor to moderate, adverse cumulative impacts. The contribution of Alternative C to the cumulative impacts would be short-term and modest.	The impacts for managing restoration actions, monitoring and evaluating restoration performance, and managing and informing visitors would be the same as in alternative C. The cumulative effects of other plans and actions combined with alternative D would be the same as alternative C; long term, minor to moderate, and adverse. The contribution of Alternative D to the cumulative impacts would be short-term and modest.	The impacts for managing restoration actions, monitoring and evaluating restoration performance, and managing and informing visitors would be the same as in alternative C. The cumulative effects of other plans and actions combined with alternative E would be the same as alternative C; long term, minor to moderate, and adverse. The contribution of Alternative E to the cumulative impacts would be short-term and modest.



PLAN VIEW



SECTION VIEW

ALTERNATIVE A, NO ACTION
MAP 1

Figure 2.2

Rocky Mountain National Park

United States Department of the Interior / National Park Service

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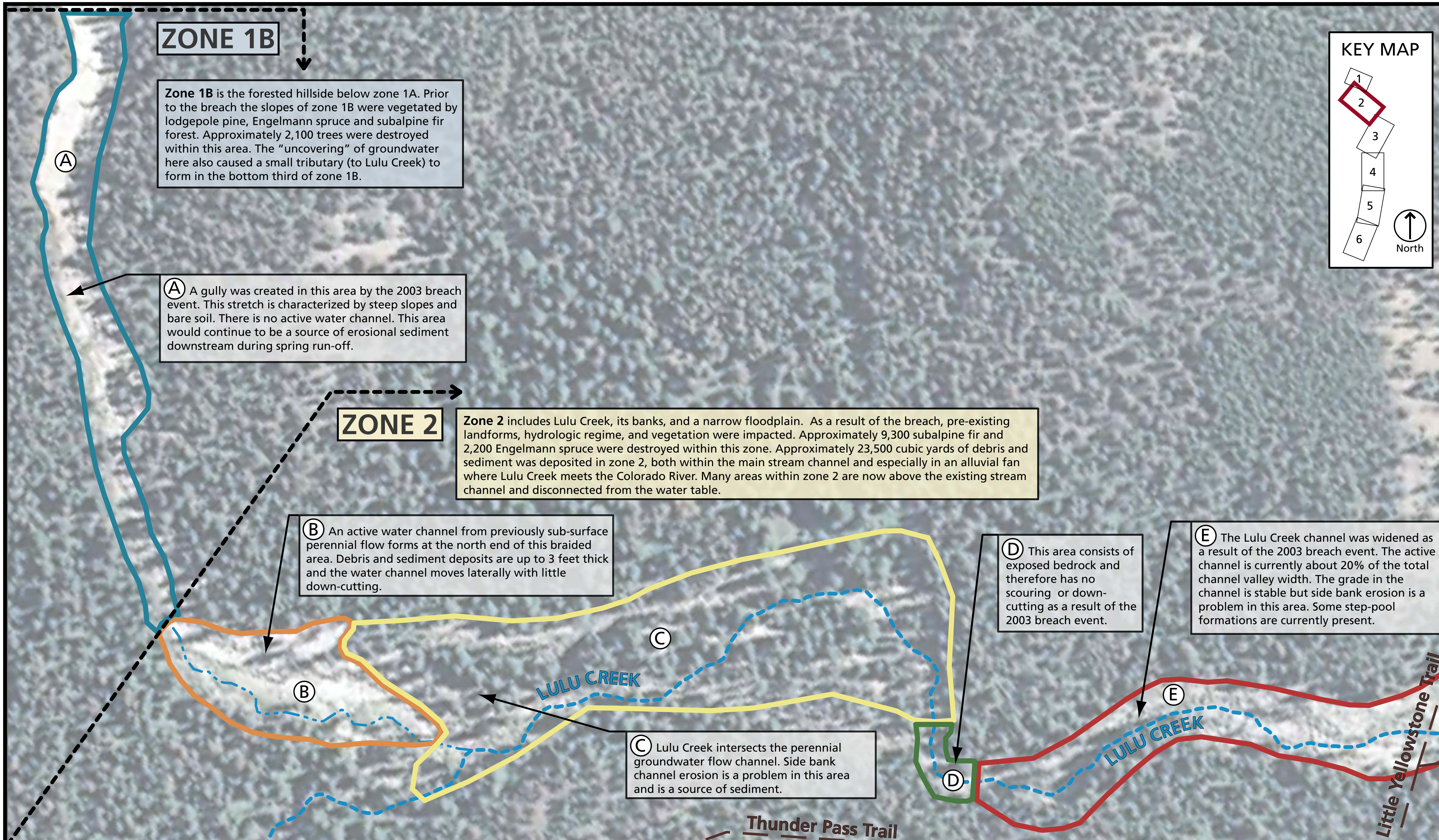

North

0′ 25′ 50′ 100′

SCALE: 1″ = 100′

ALTERNATIVE A, NO ACTION
MAP 2

Figure 2.3

Rocky Mountain National Park

United States Department of the Interior / National Park Service

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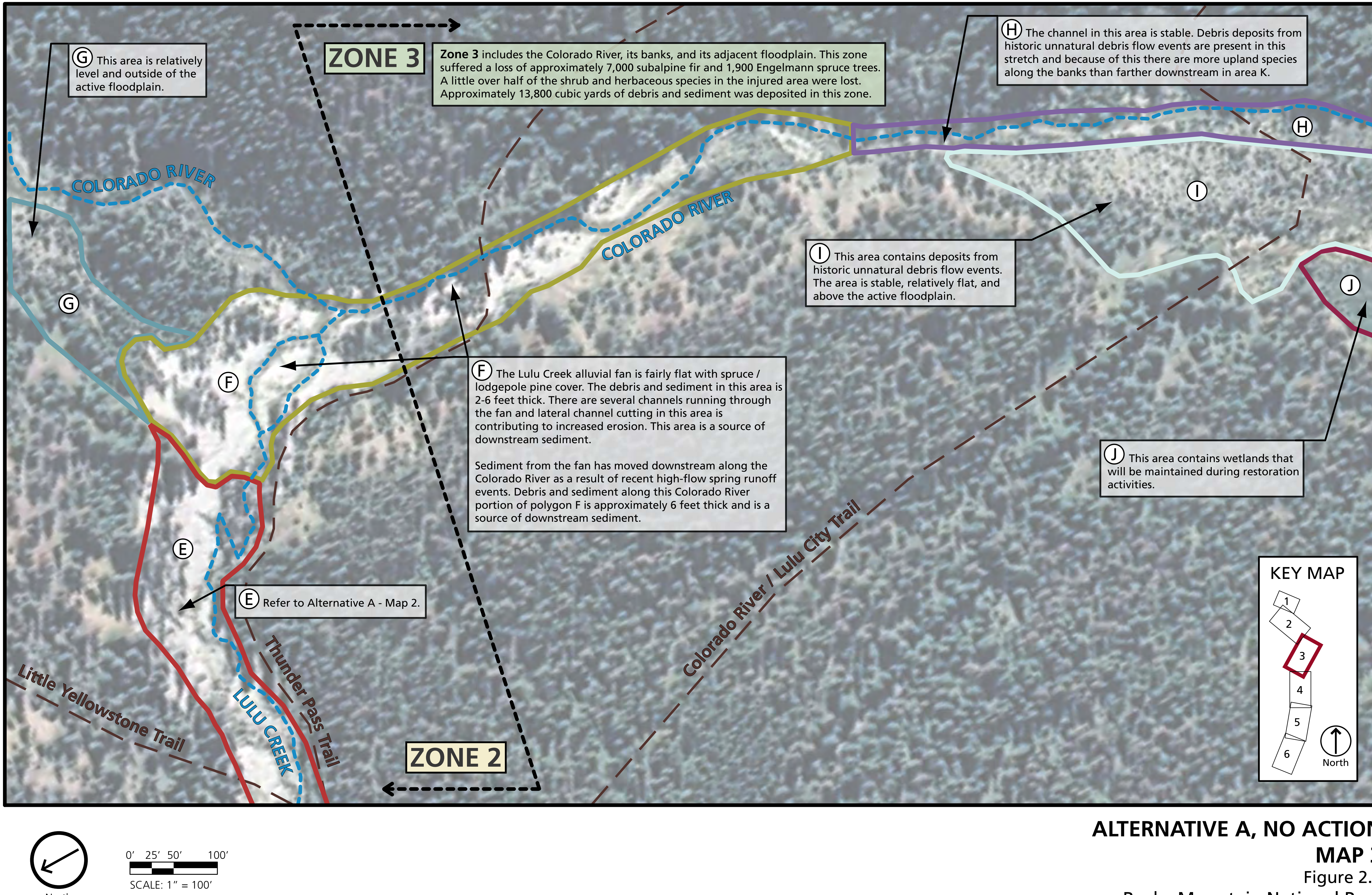

ALTERNATIVE A, NO ACTION
MAP 3
Figure 2.4
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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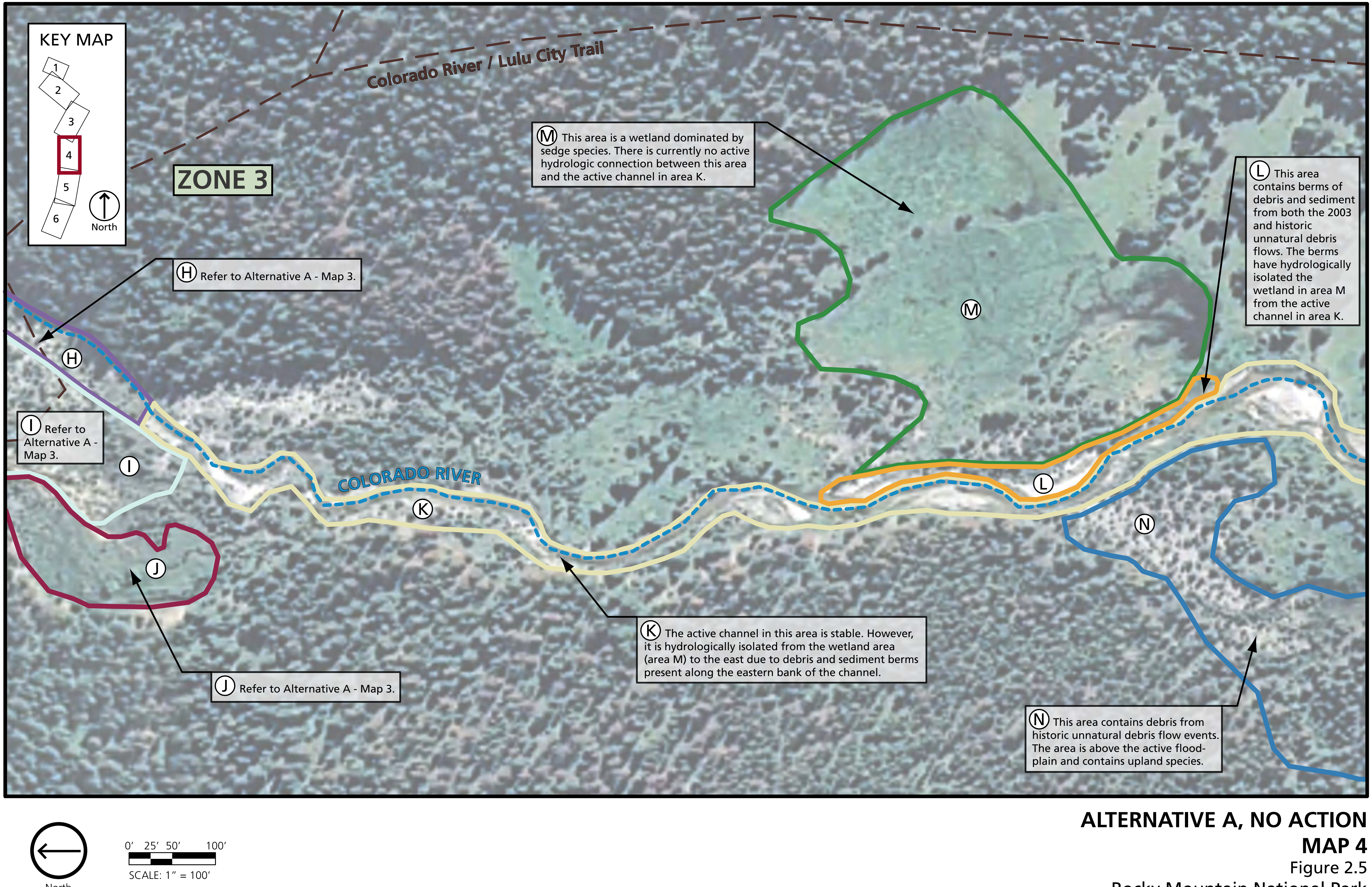

ALTERNATIVE A, NO ACTION
MAP 4
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United States Department of the Interior / National Park Service

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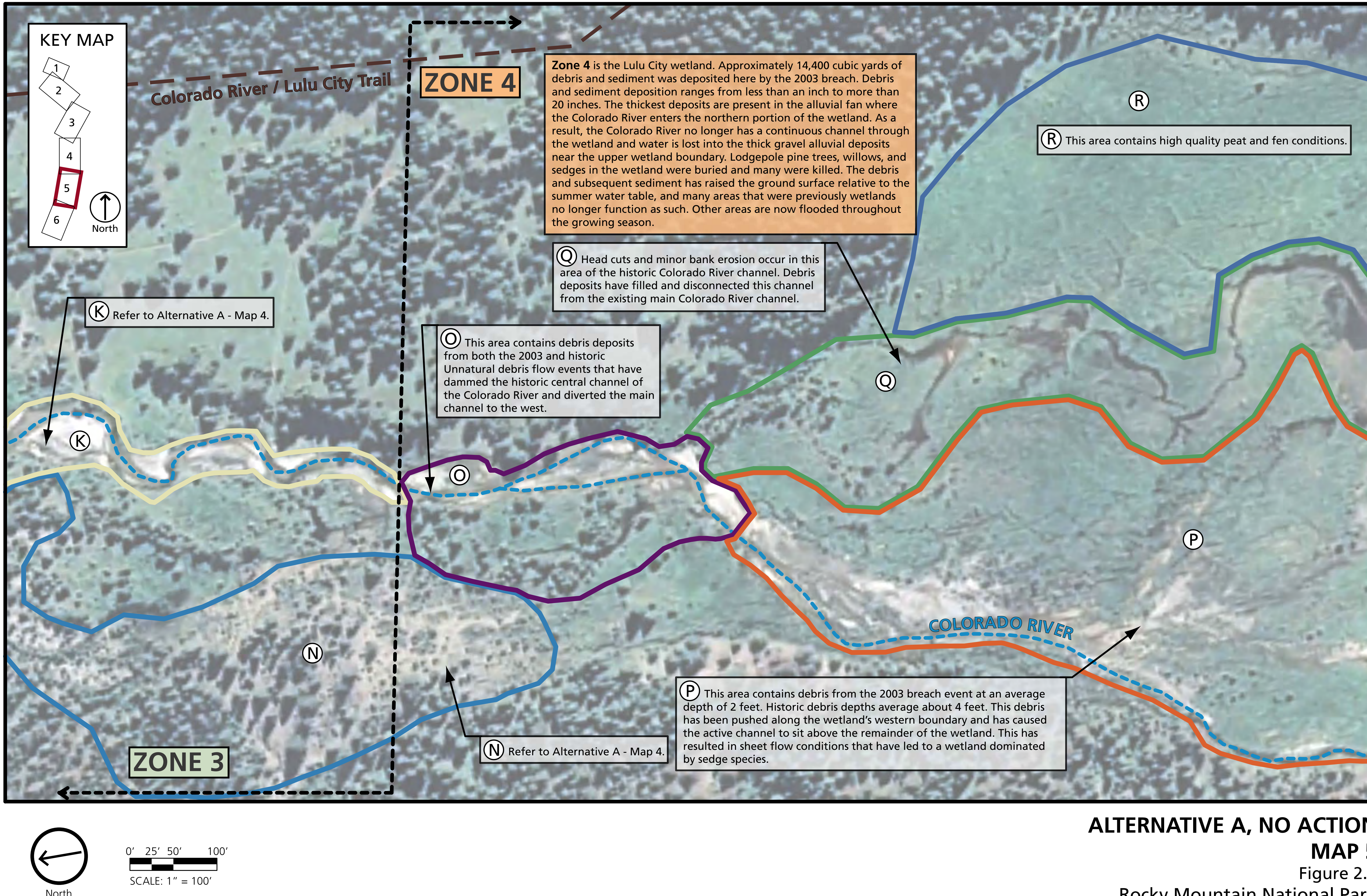

ALTERNATIVE A, NO ACTION
MAP 5
Figure 2.6
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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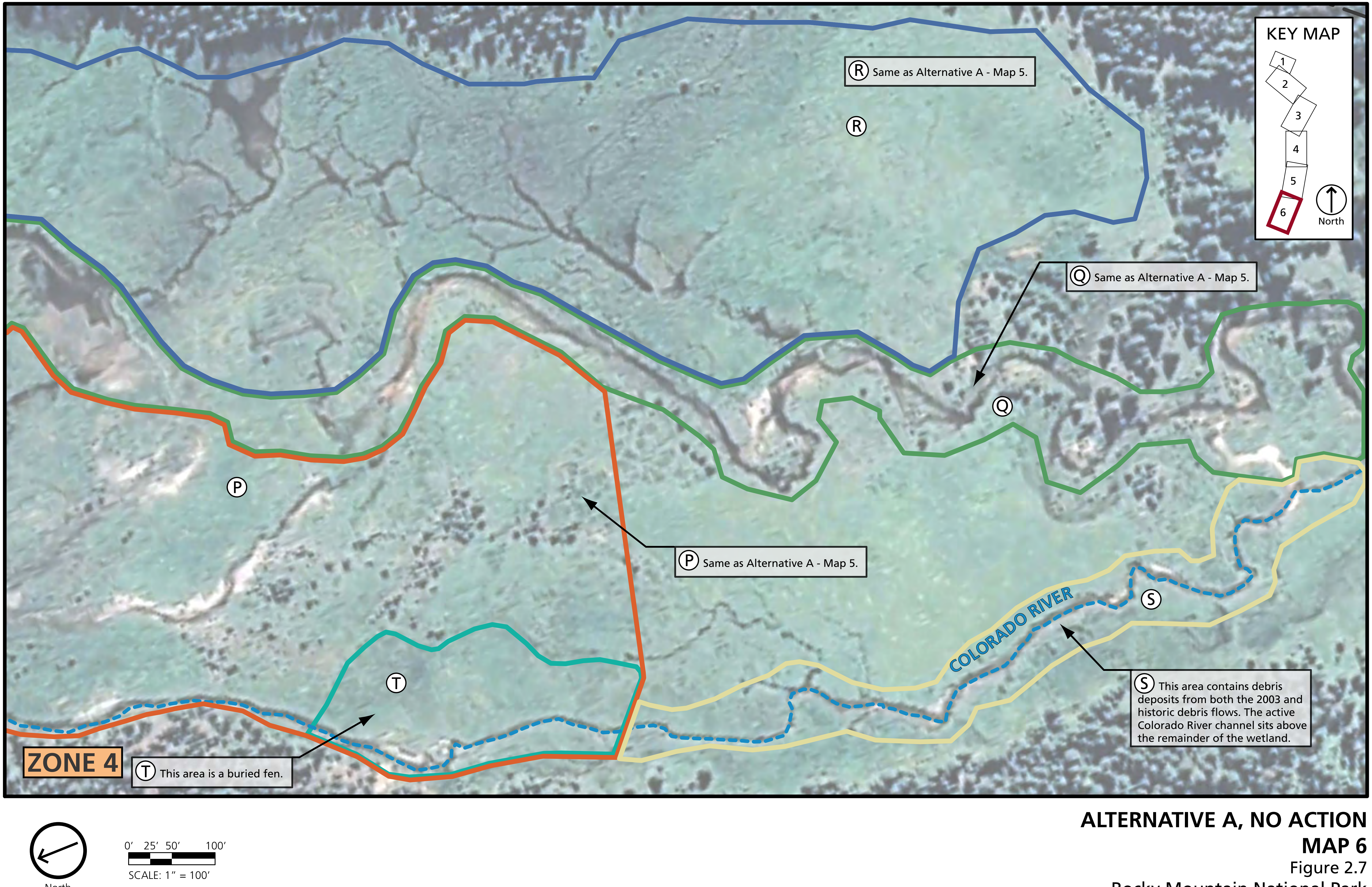

ALTERNATIVE A, NO ACTION
MAP 6
Figure 2.7
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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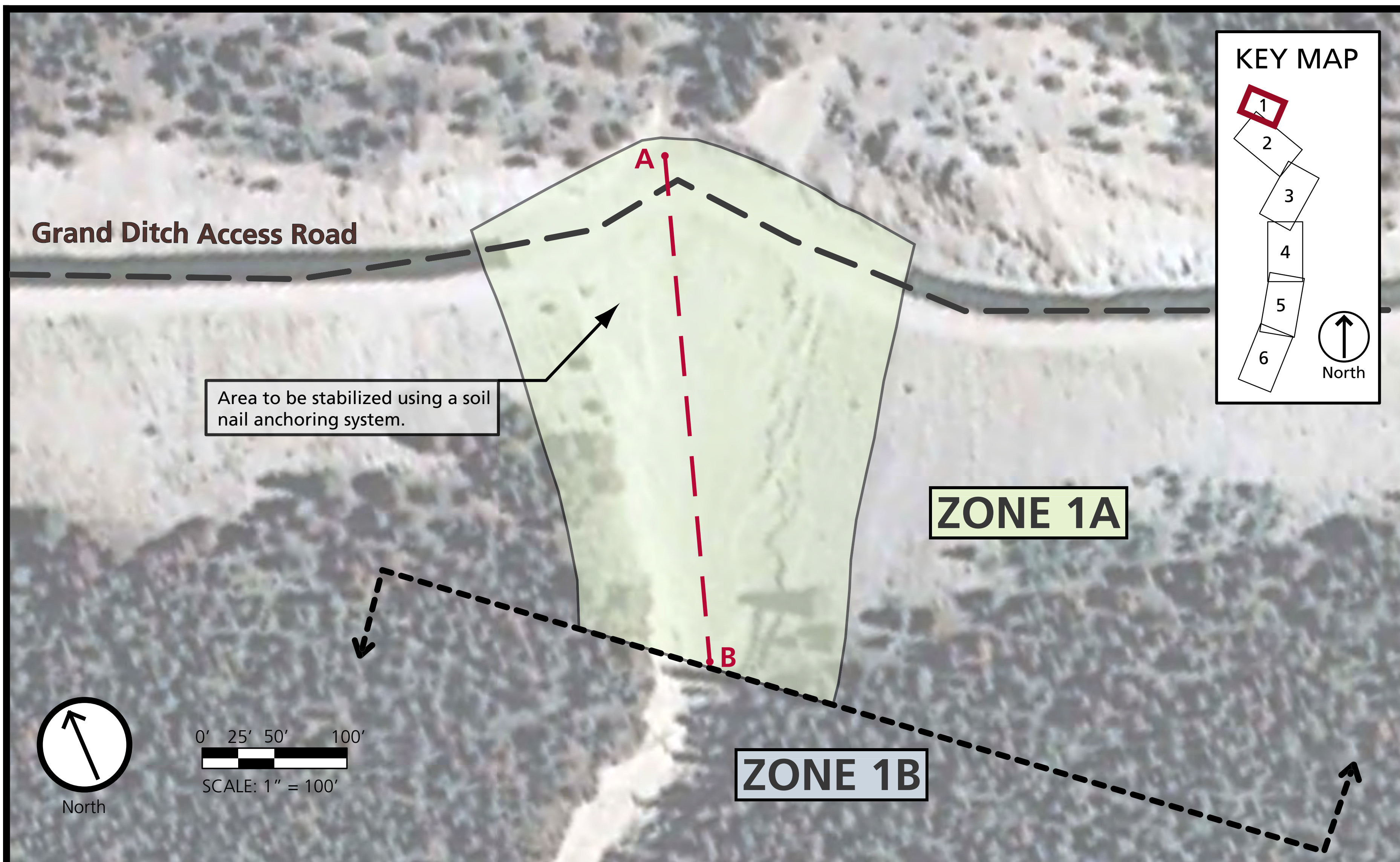
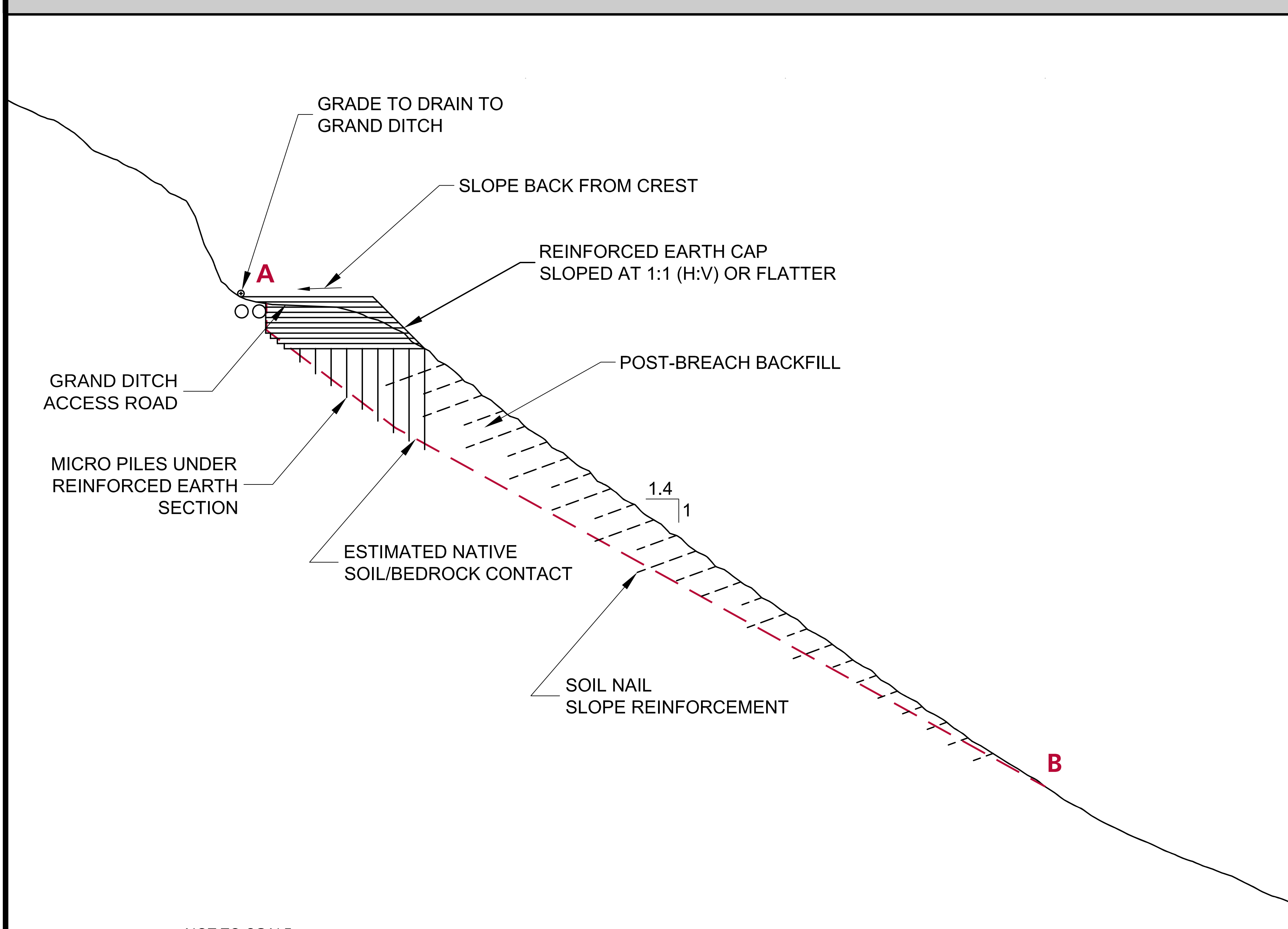


PLAN VIEW



SECTION VIEW

ZONE 1A - OPTION 1 FOR ALL ACTION ALTERNATIVES: SOIL NAIL SLOPE STABILIZATION

MAP 1

Figure 2.8

Rocky Mountain National Park

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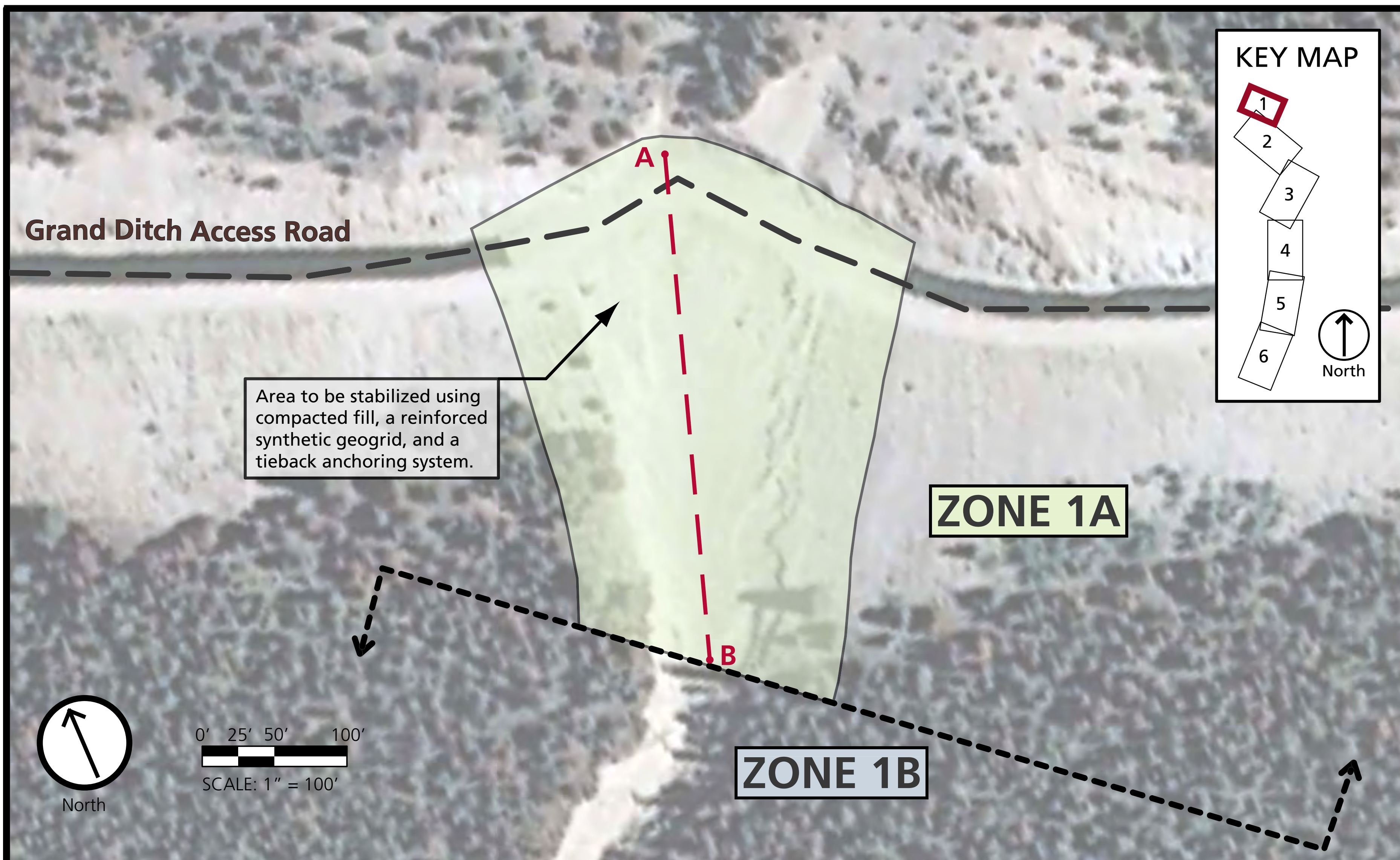
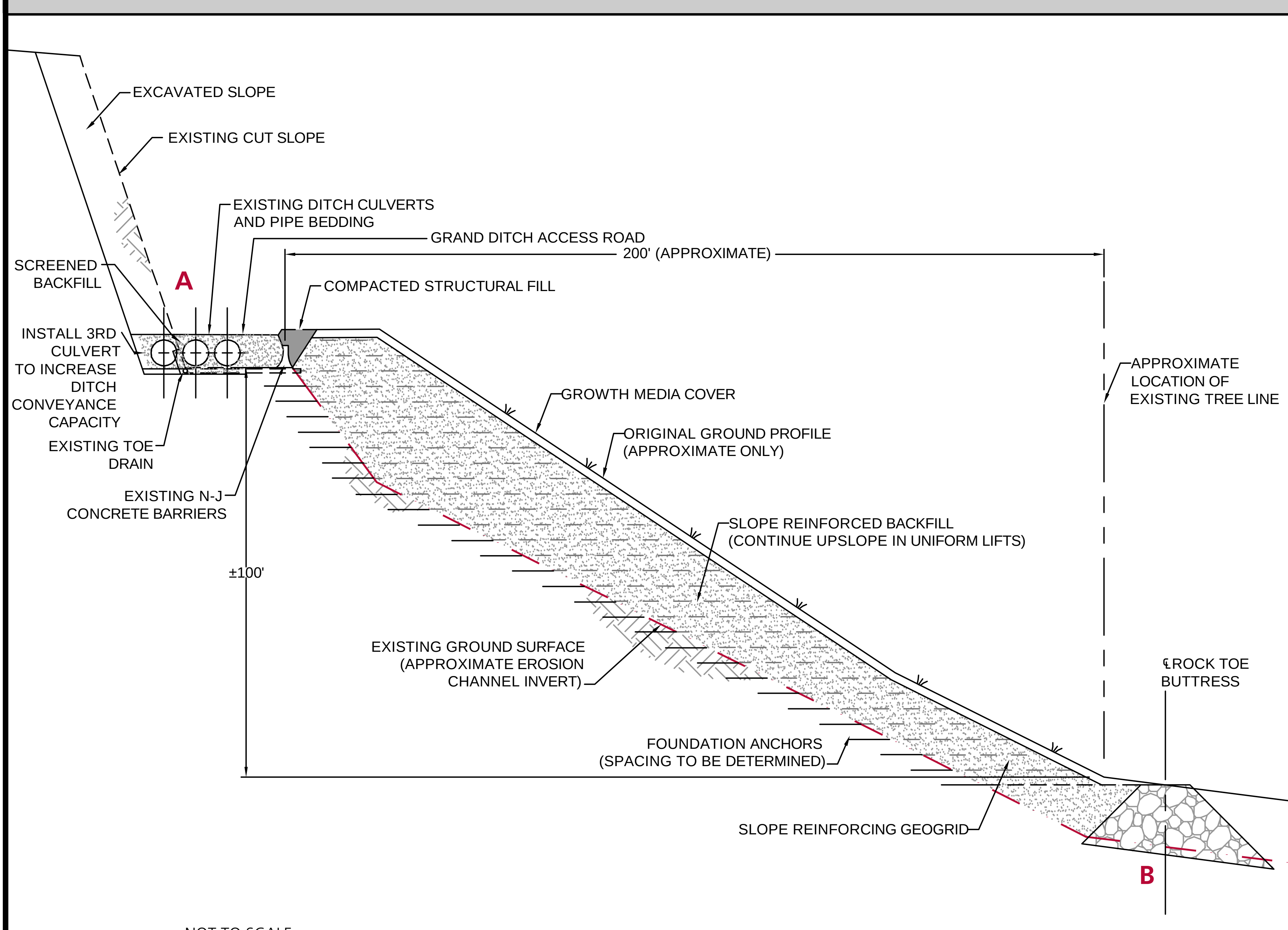


PLAN VIEW



SECTION VIEW

ZONE 1A - OPTION 2 FOR ALTERNATIVES B, C, AND E: BACKFILL AND REINFORCEMENT SLOPE STABILIZATION

MAP 1

Figure 2.9

Rocky Mountain National Park

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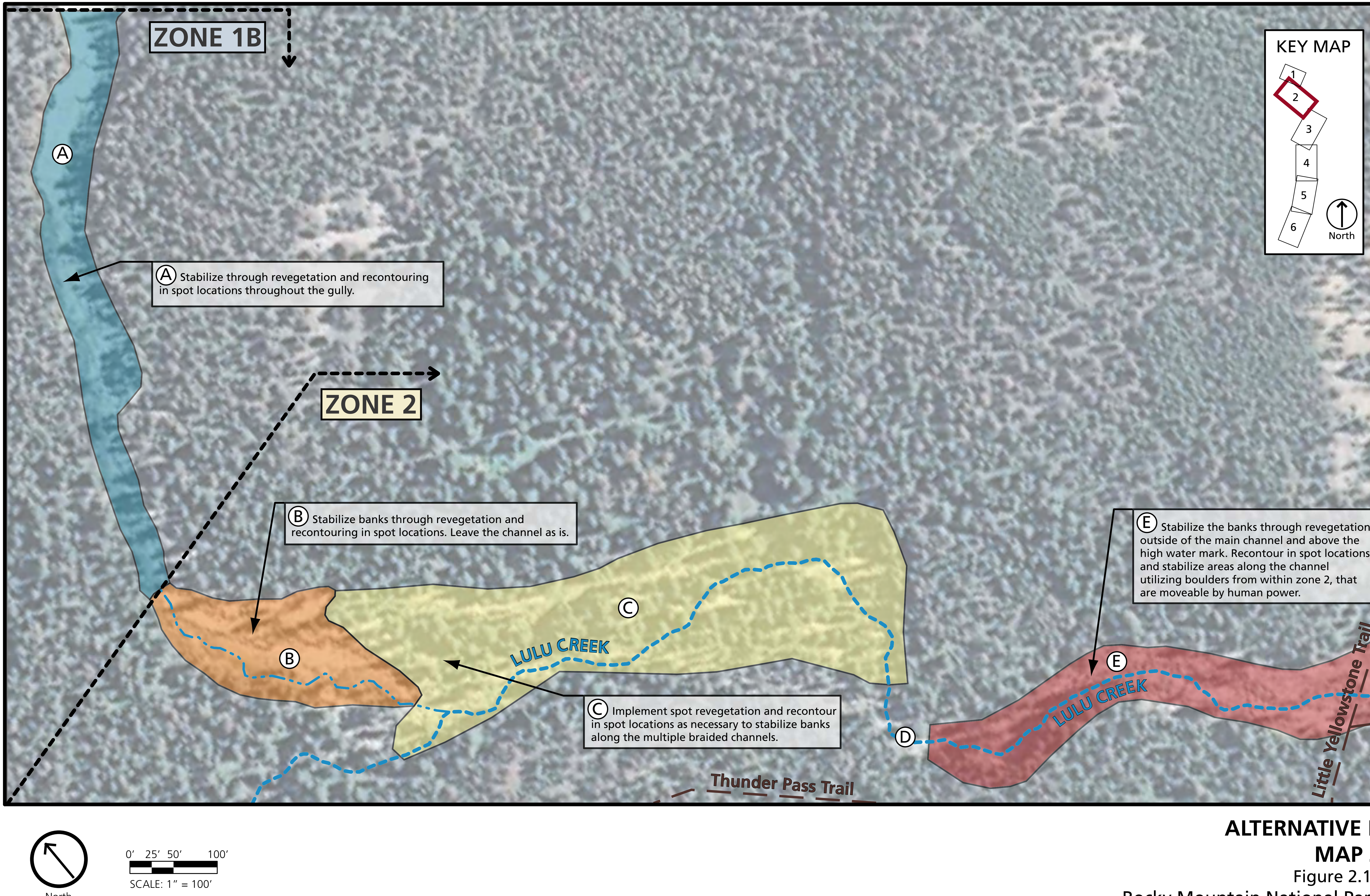

ALTERNATIVE B
MAP 2
Figure 2.10
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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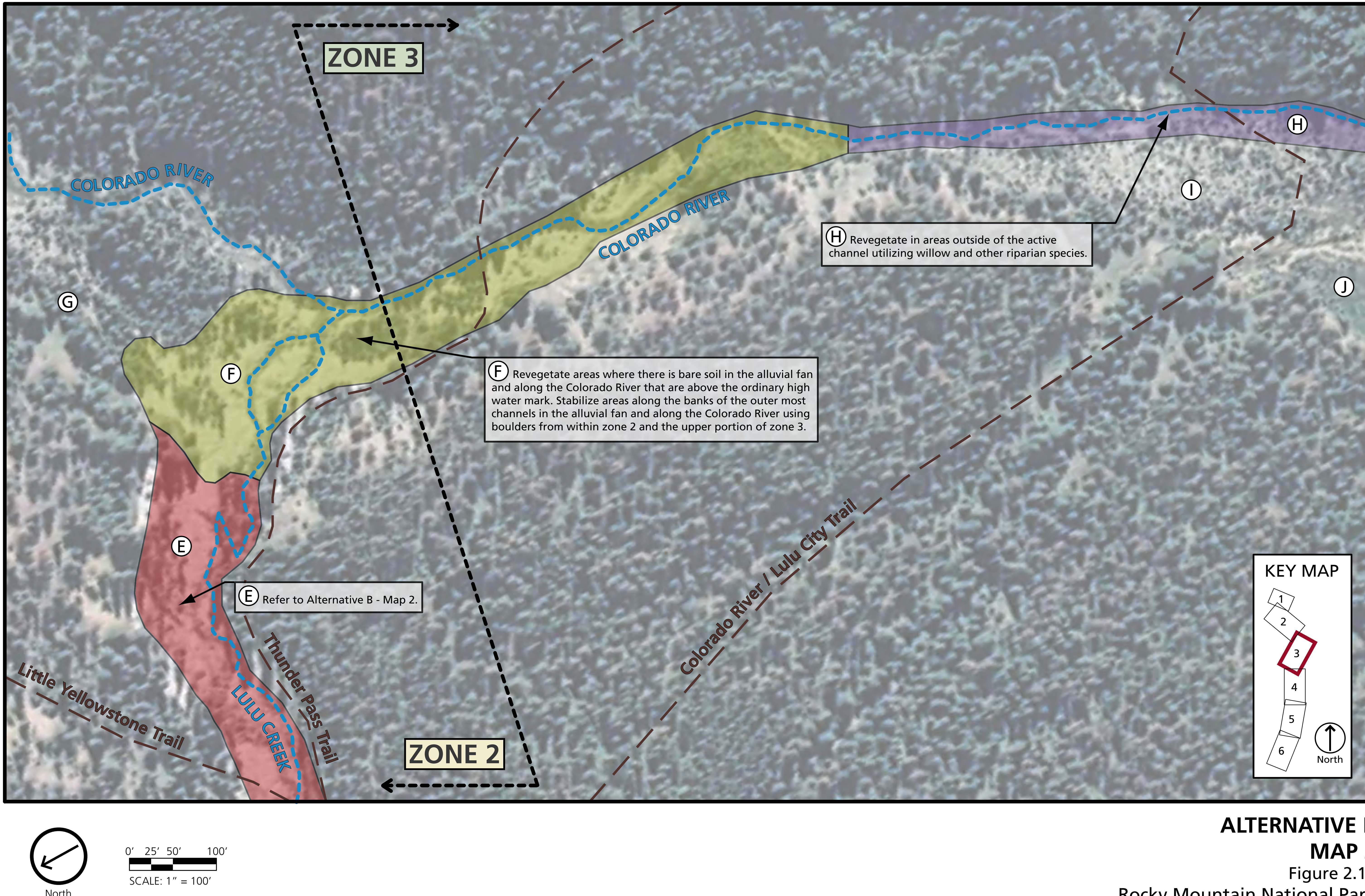

ALTERNATIVE B
MAP 3

Figure 2.11

Rocky Mountain National Park

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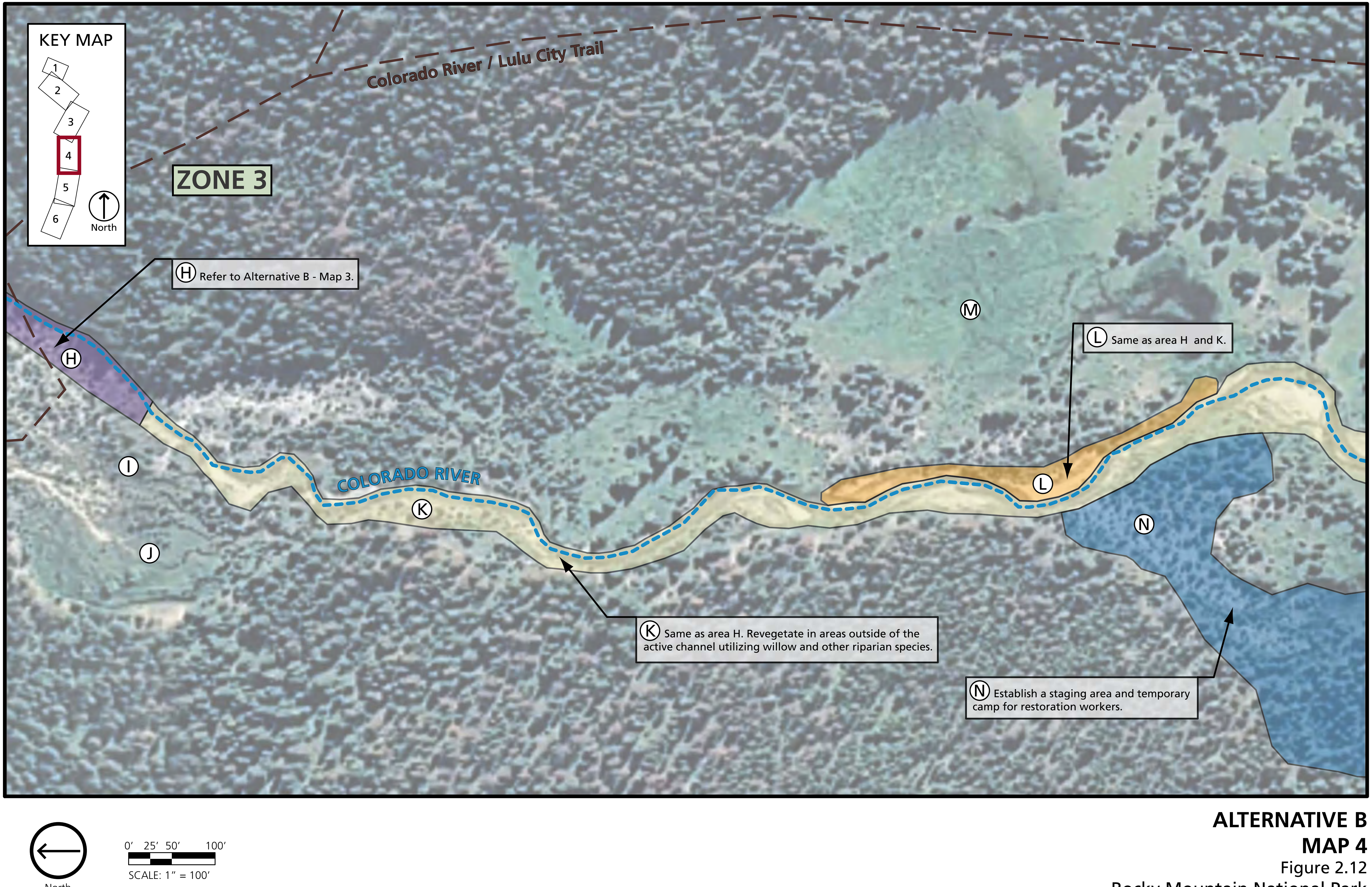

ALTERNATIVE B
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United States Department of the Interior / National Park Service

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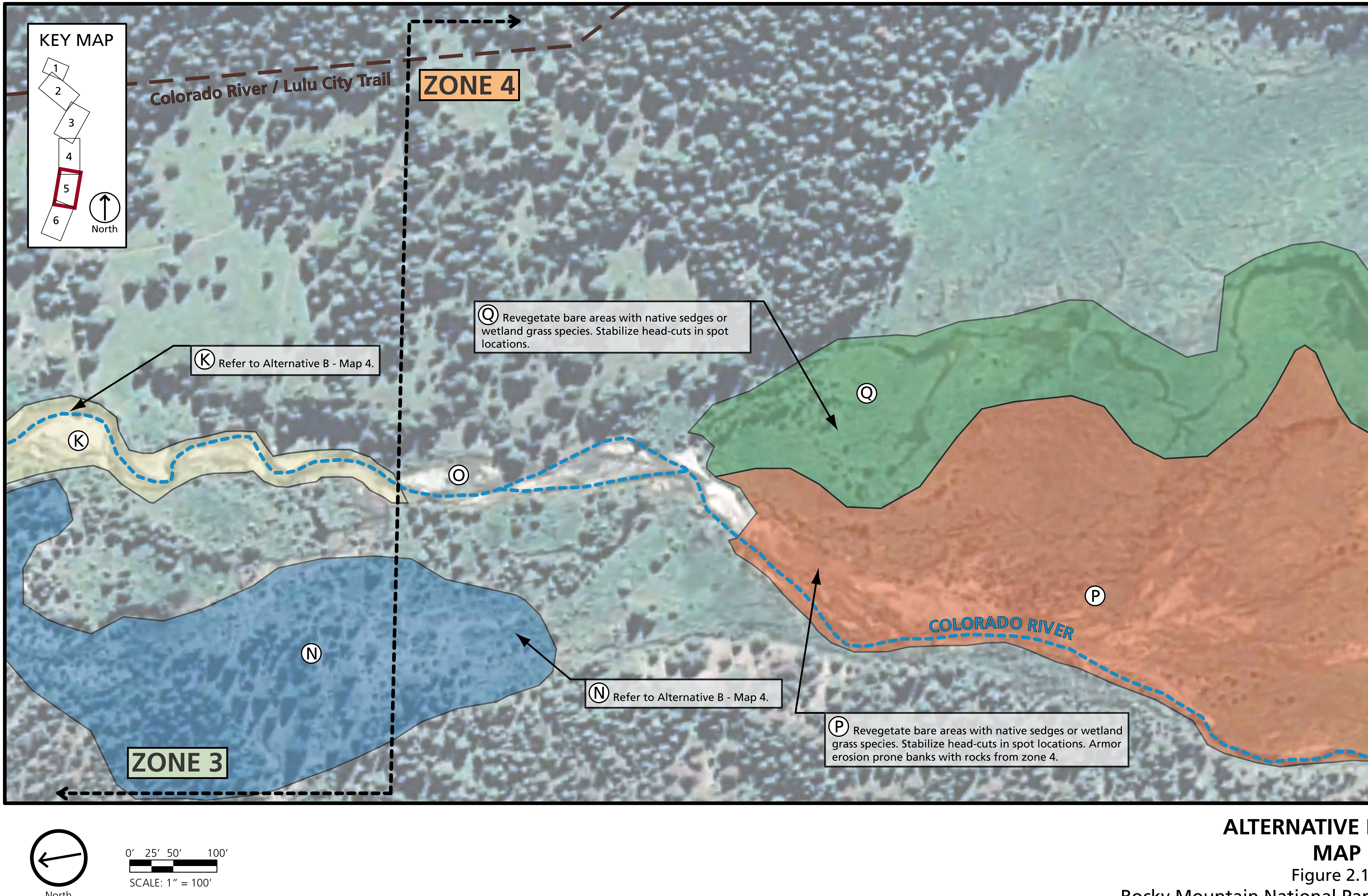

ALTERNATIVE B
MAP 5
Figure 2.13
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United States Department of the Interior / National Park Service

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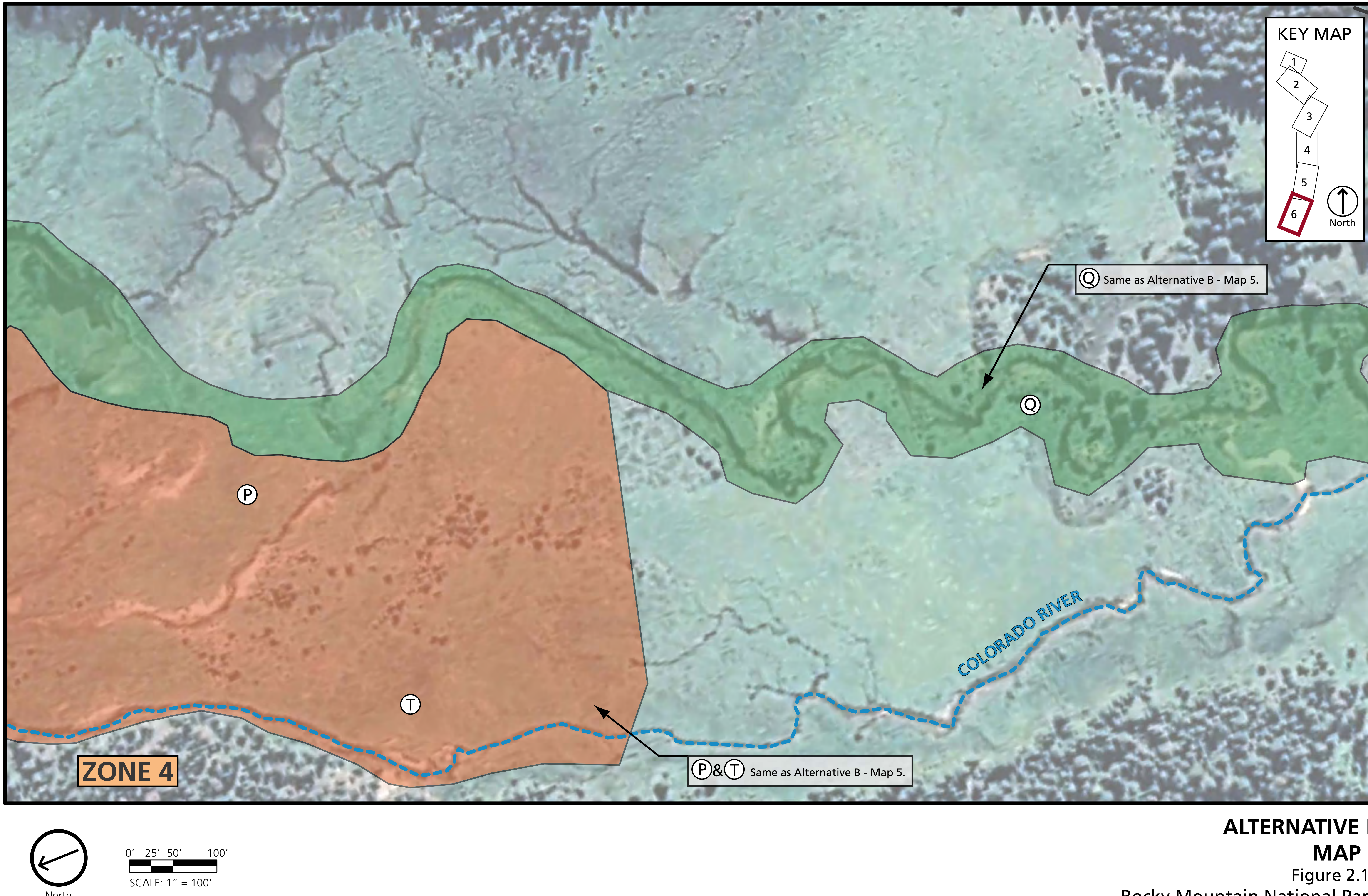

ALTERNATIVE B
MAP 6
Figure 2.14
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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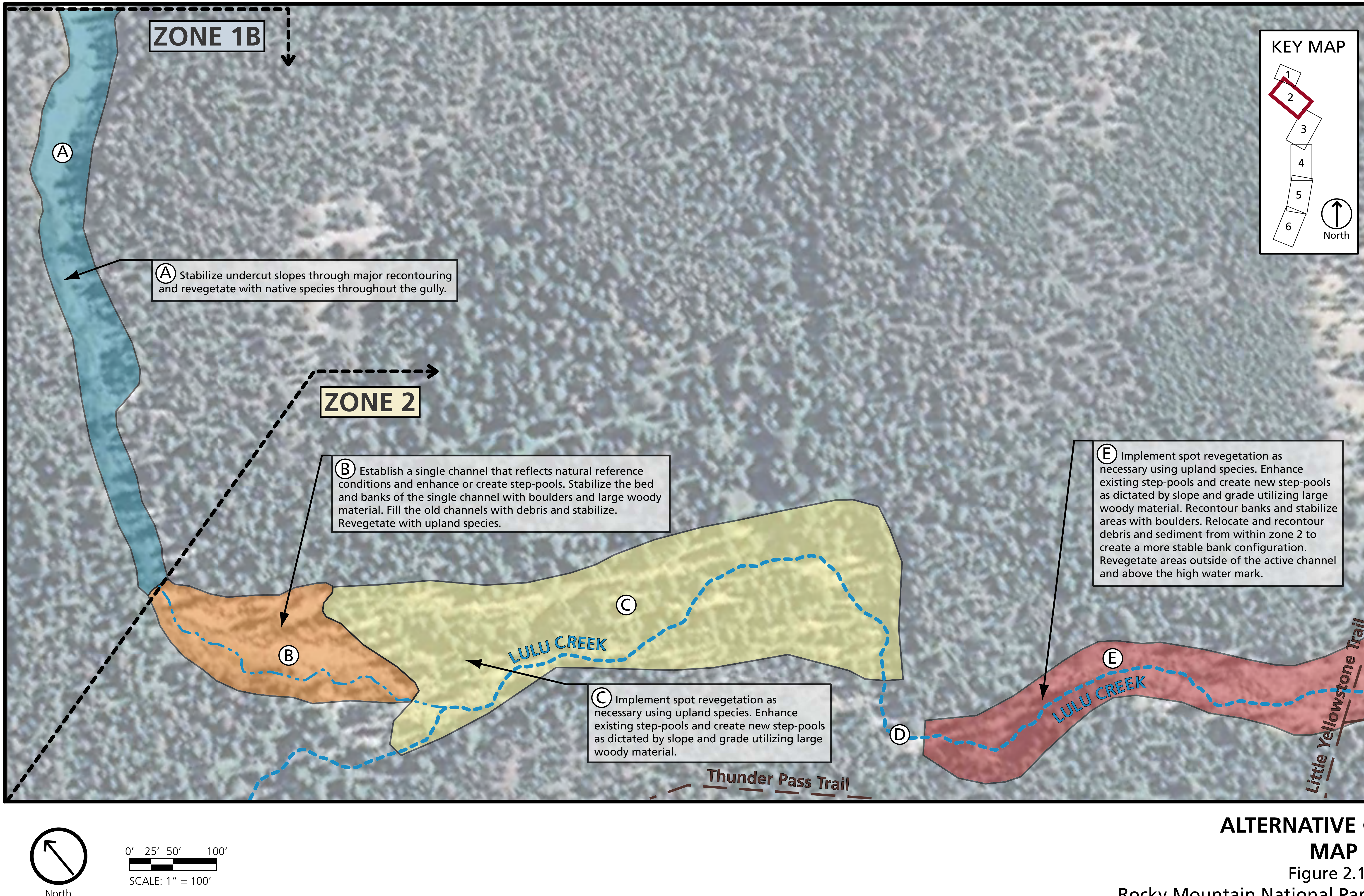

ALTERNATIVE C
MAP 2
Figure 2.15
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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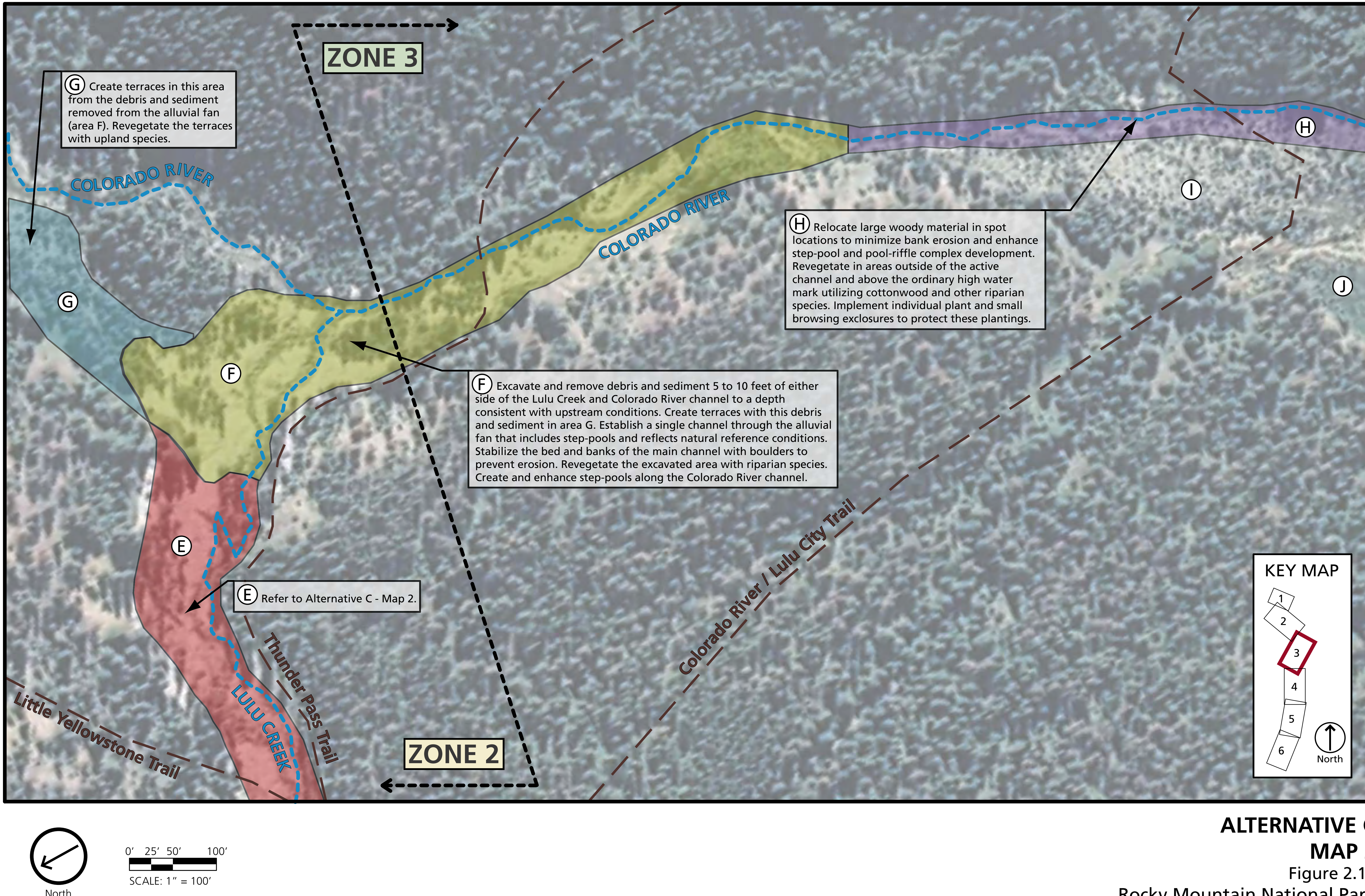

ALTERNATIVE C
MAP 3
Figure 2.16
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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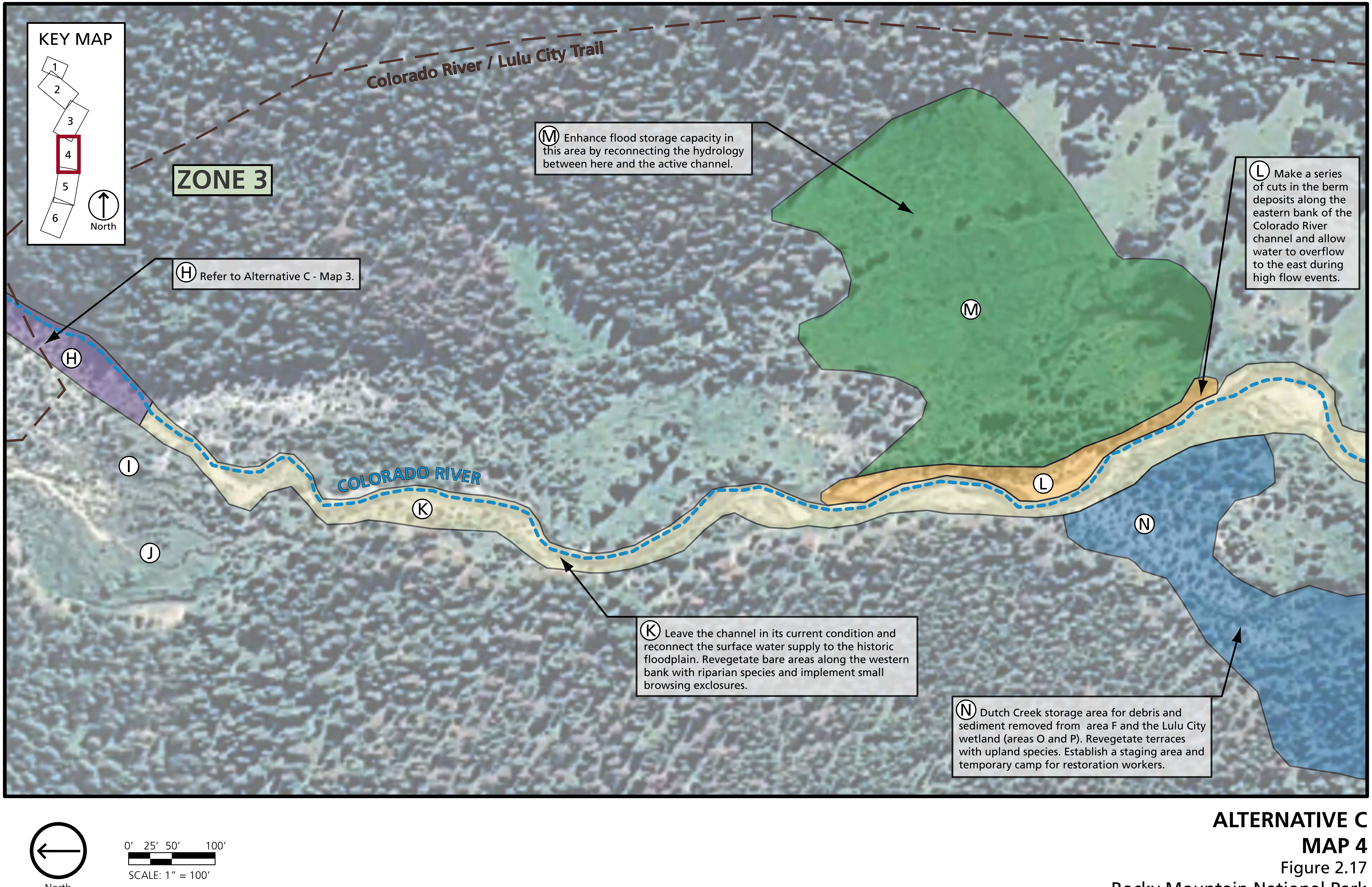

ALTERNATIVE C
MAP 4
Figure 2.17
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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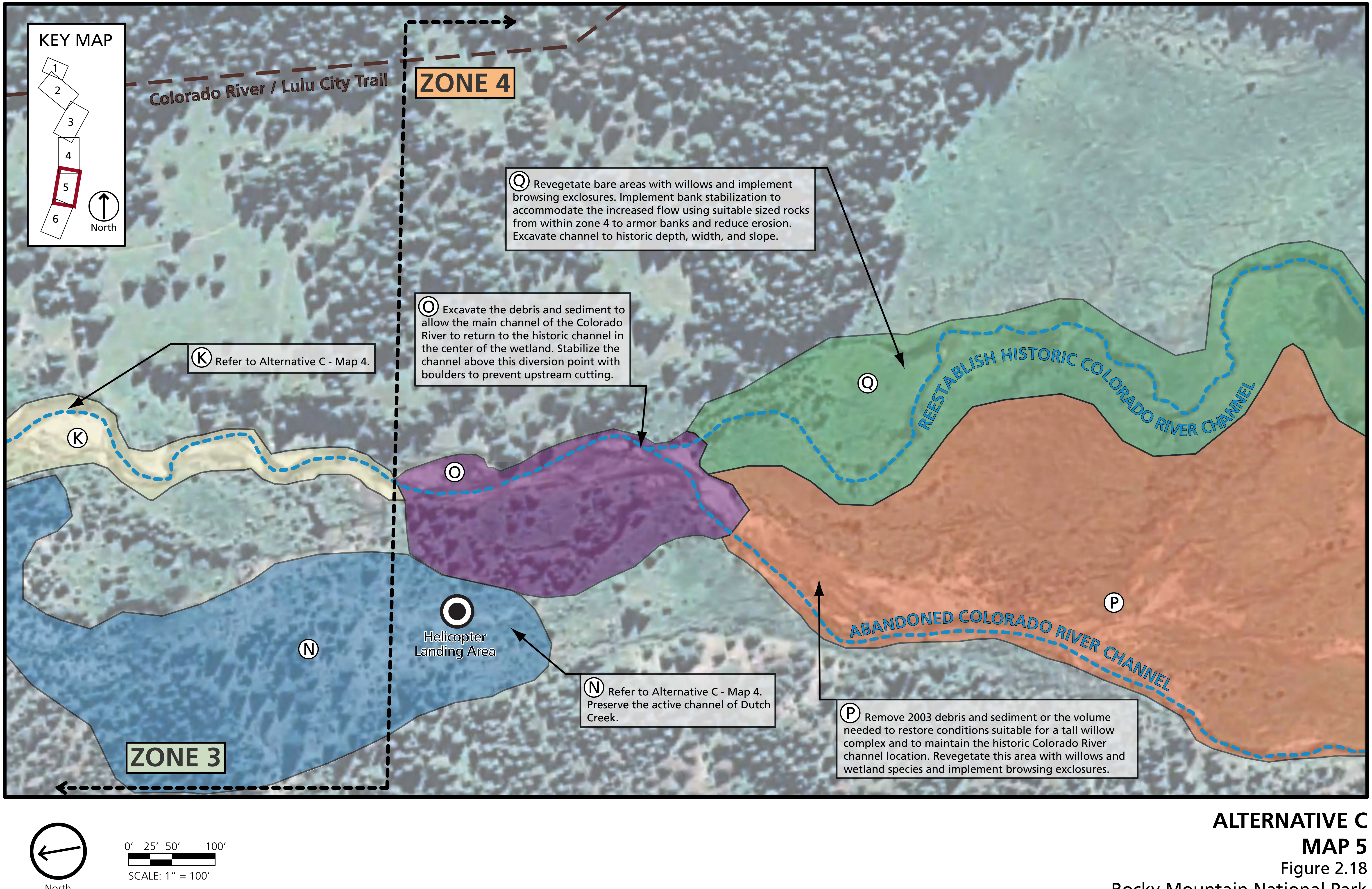

ALTERNATIVE C
MAP 5
Figure 2.18
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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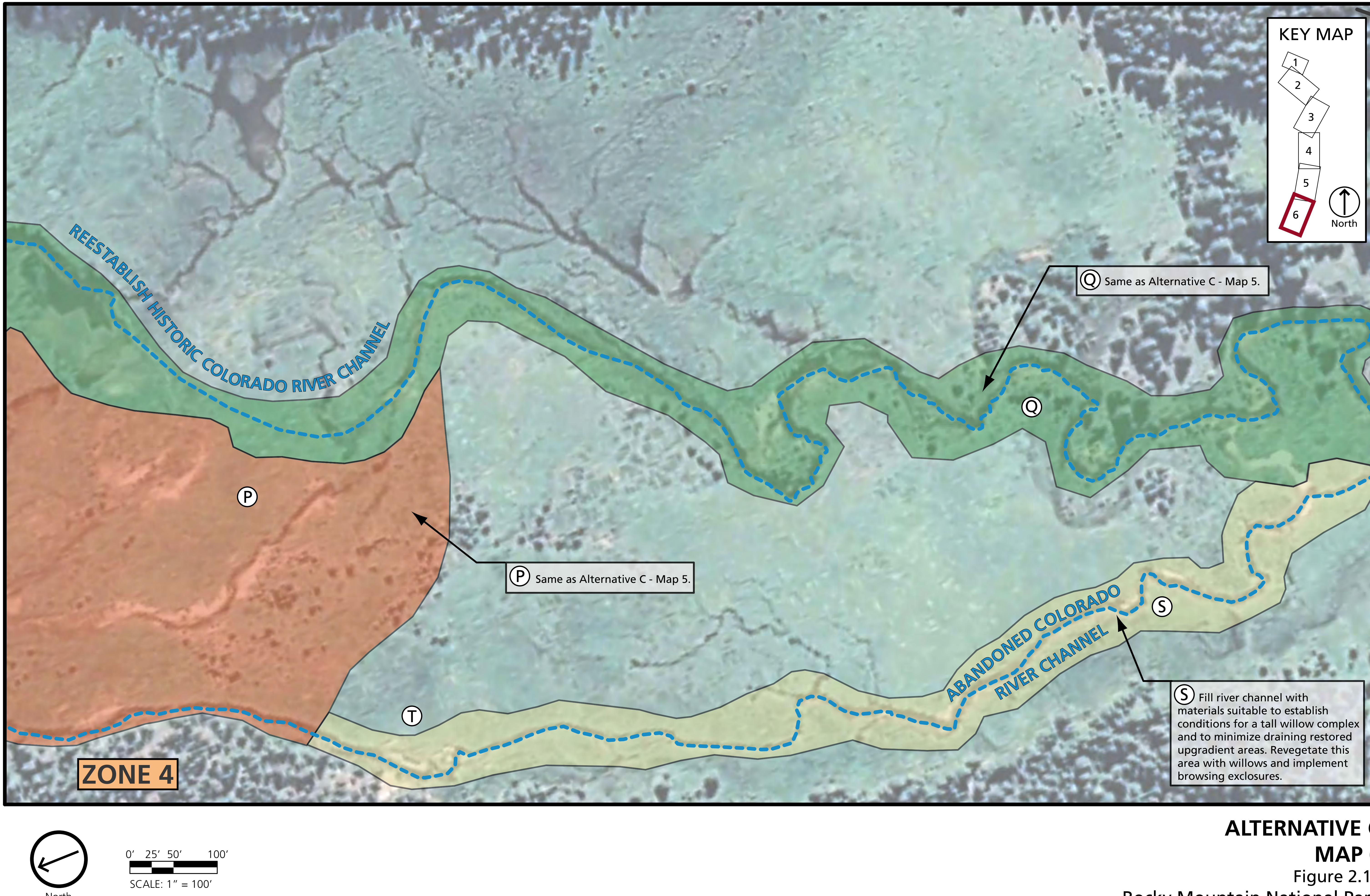

ALTERNATIVE C
MAP 6

Figure 2.19

Rocky Mountain National Park

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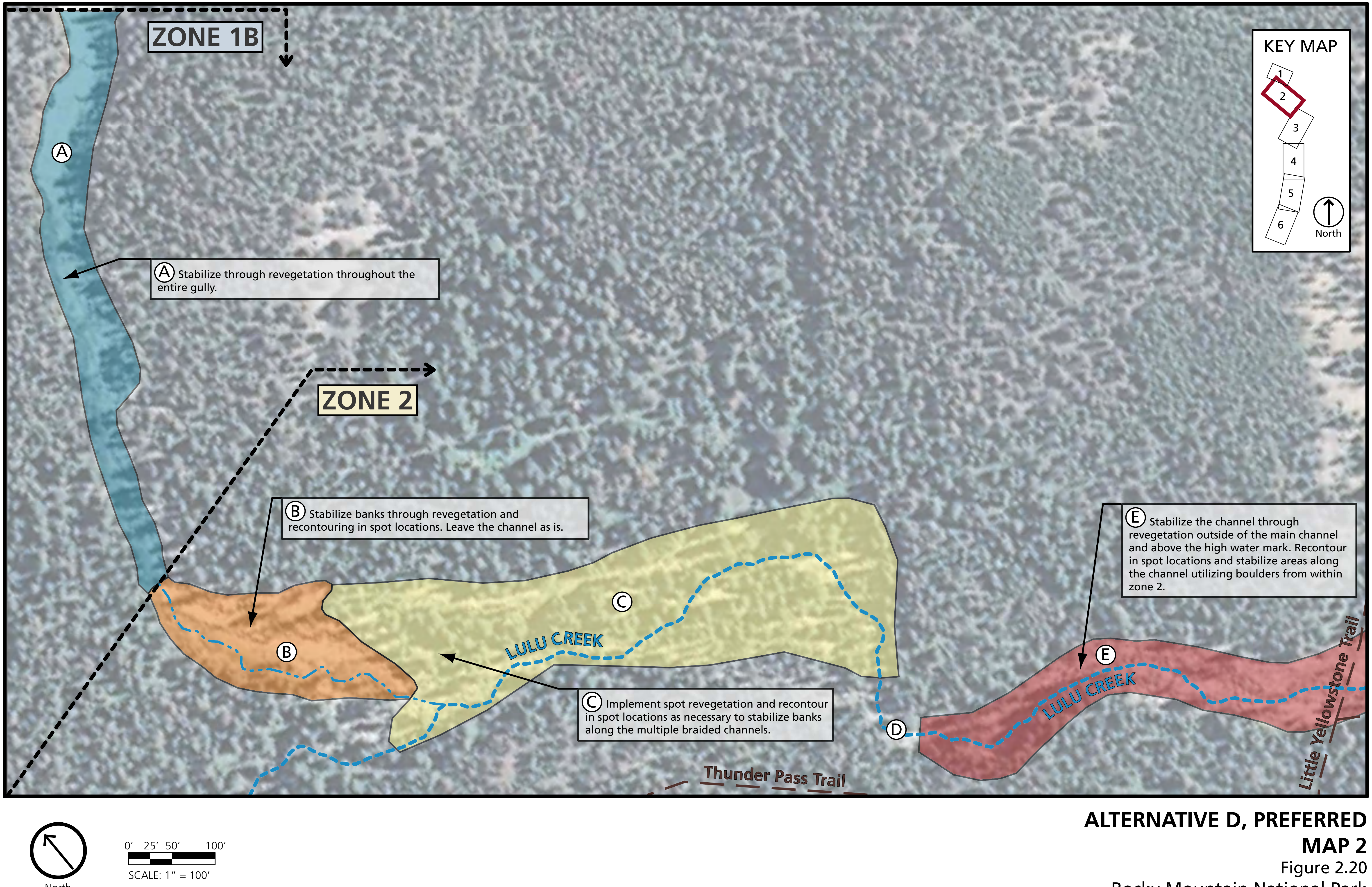

ALTERNATIVE D, PREFERRED
MAP 2
Figure 2.20
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United States Department of the Interior / National Park Service

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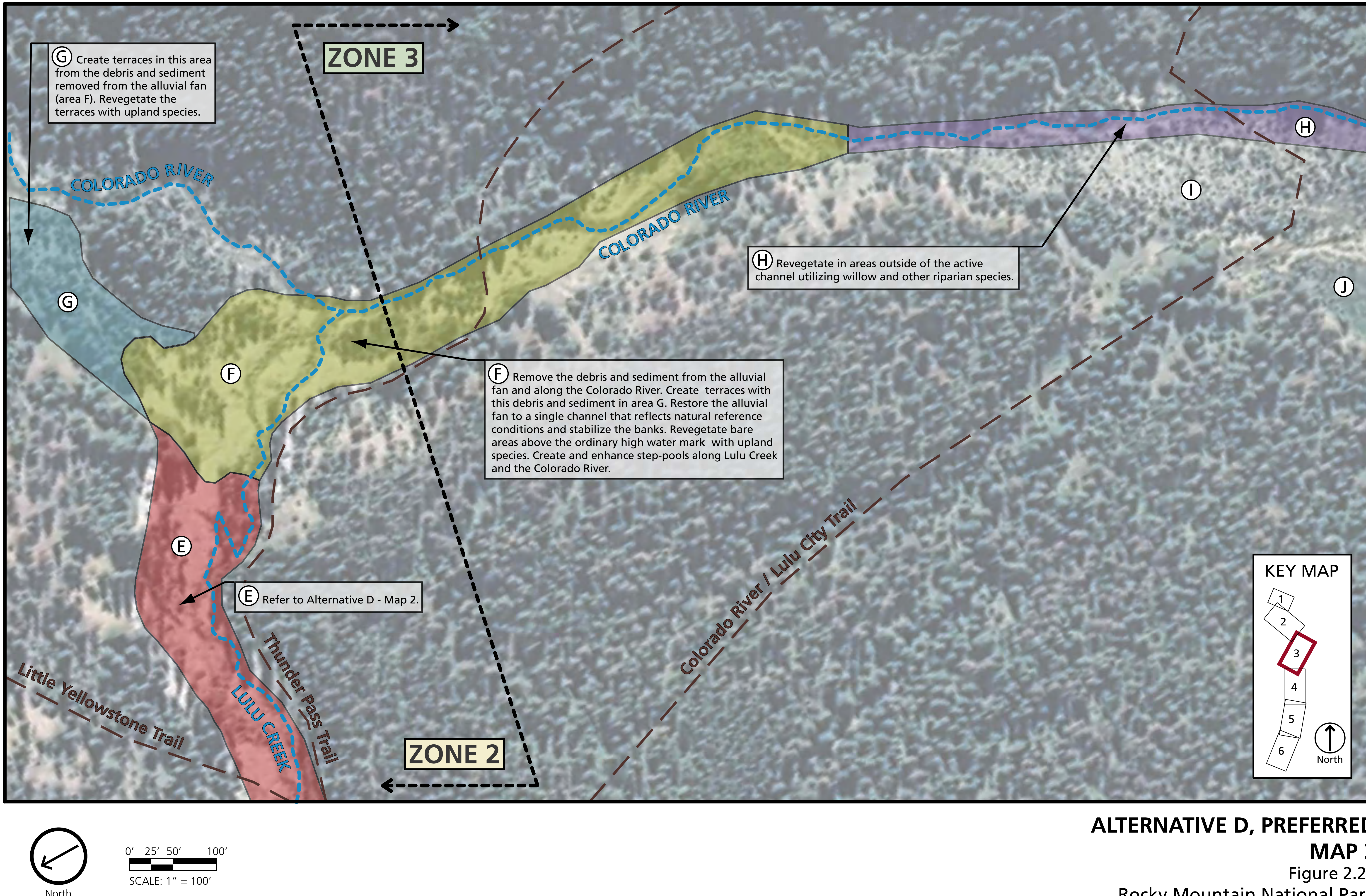

ALTERNATIVE D, PREFERRED

MAP 3

Figure 2.21

Rocky Mountain National Park

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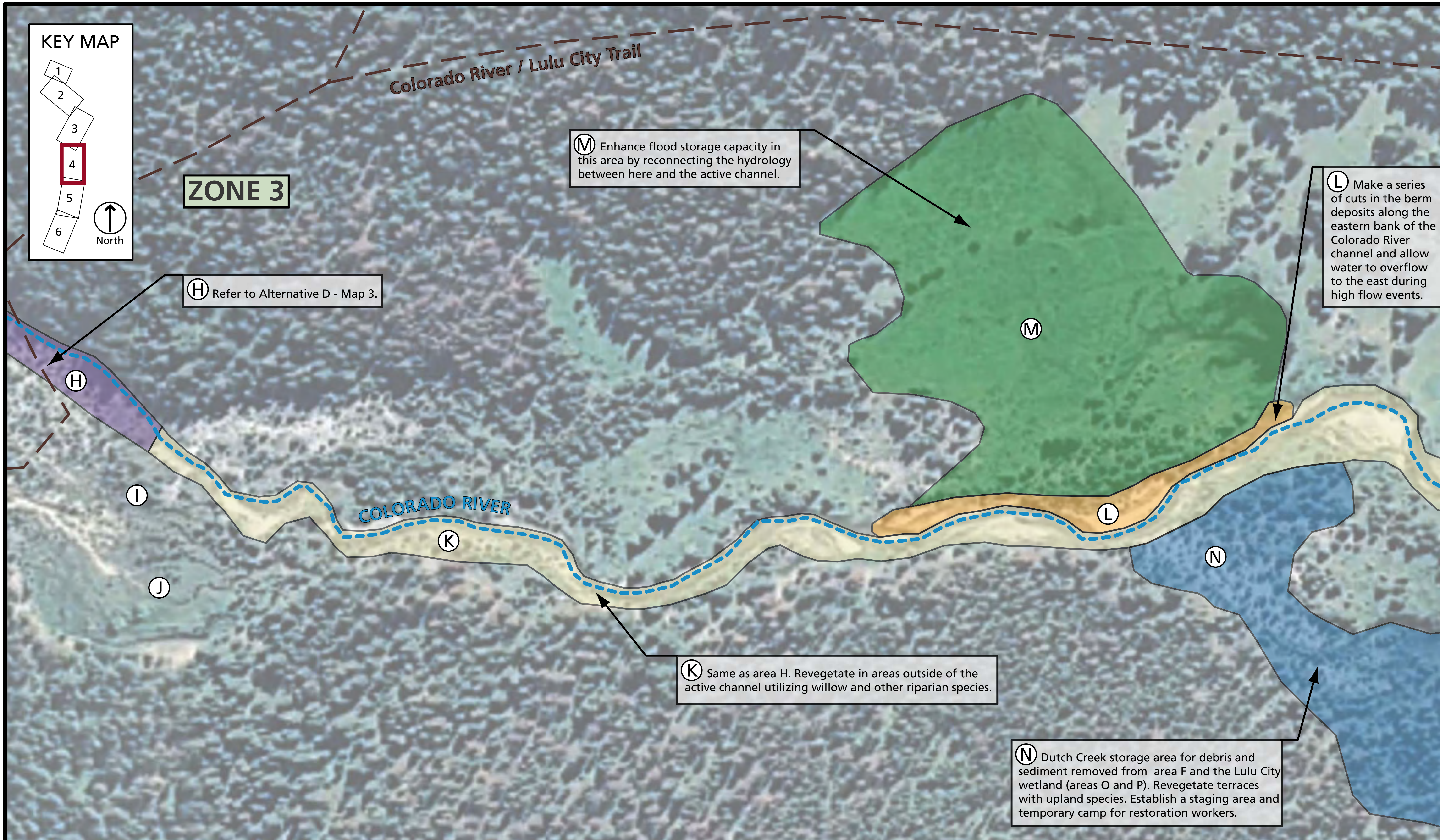

North

0′ 25′ 50′ 100′

SCALE: 1″ = 100′

ALTERNATIVE D, PREFERRED
MAP 4
Figure 2.22
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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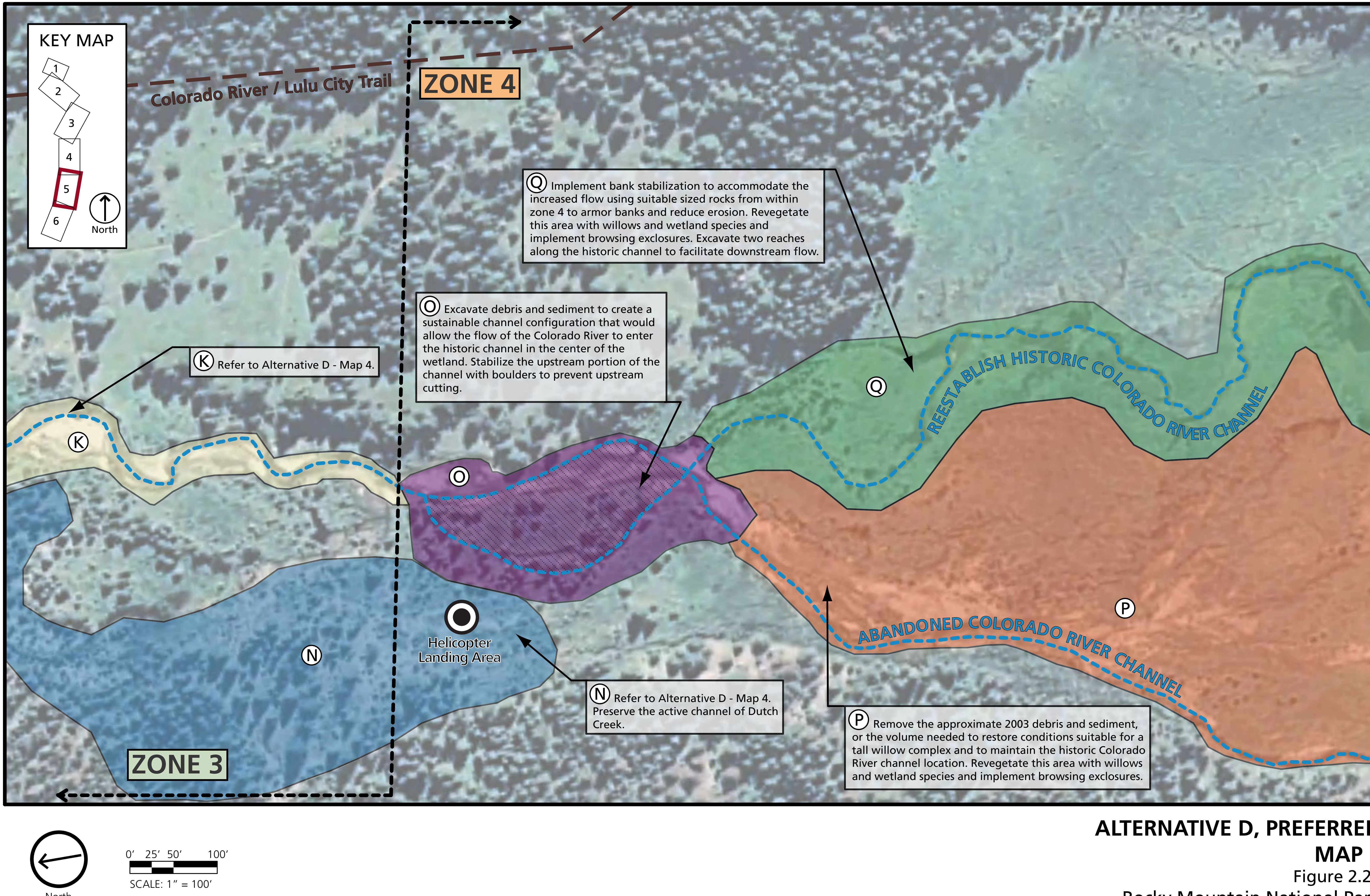

ALTERNATIVE D, PREFERRED

MAP 5

Figure 2.23

Rocky Mountain National Park

United States Department of the Interior / National Park Service

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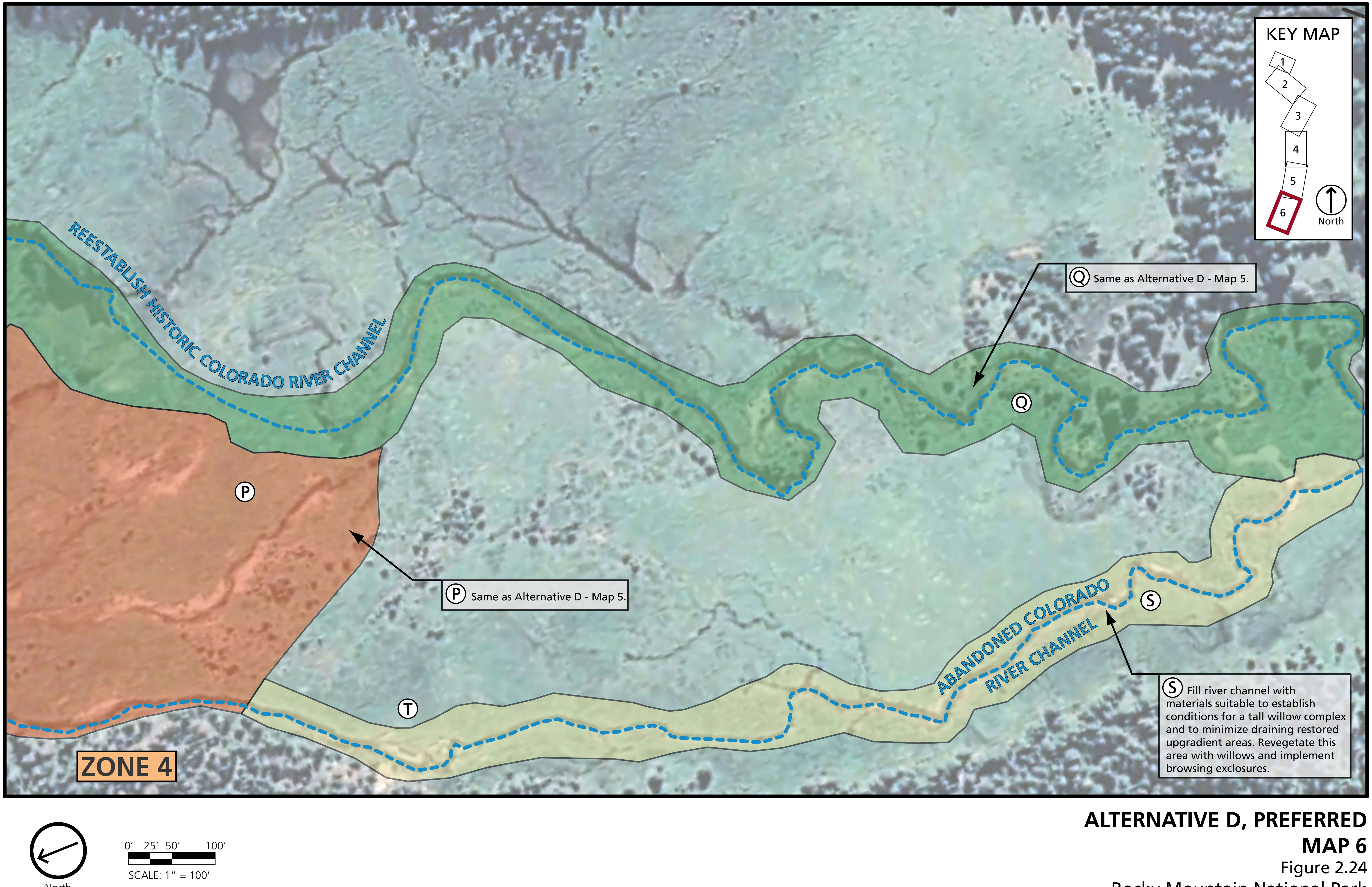

ALTERNATIVE D, PREFERRED
MAP 6
Figure 2.24
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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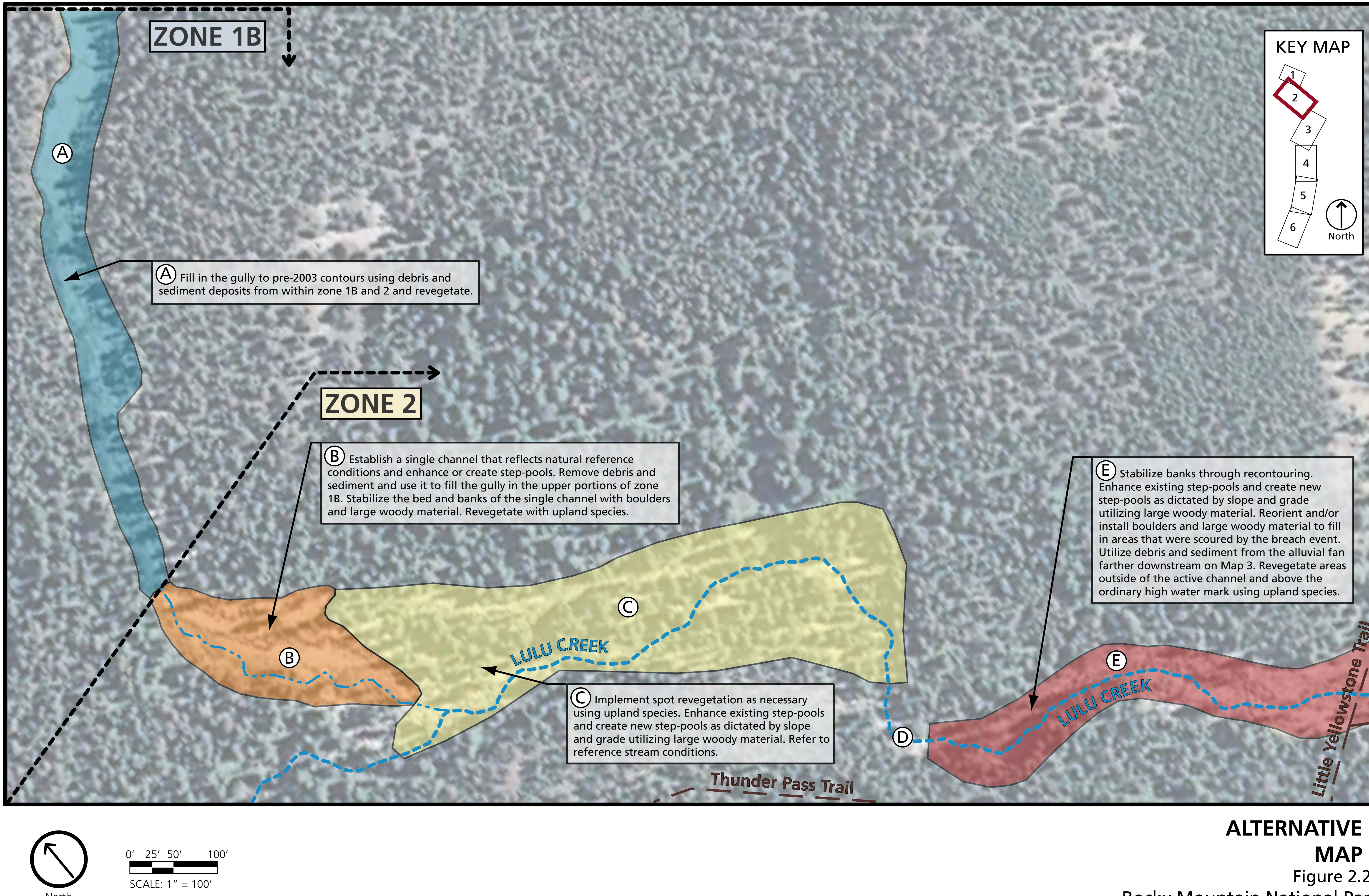

ALTERNATIVE E
MAP 2
Figure 2.25
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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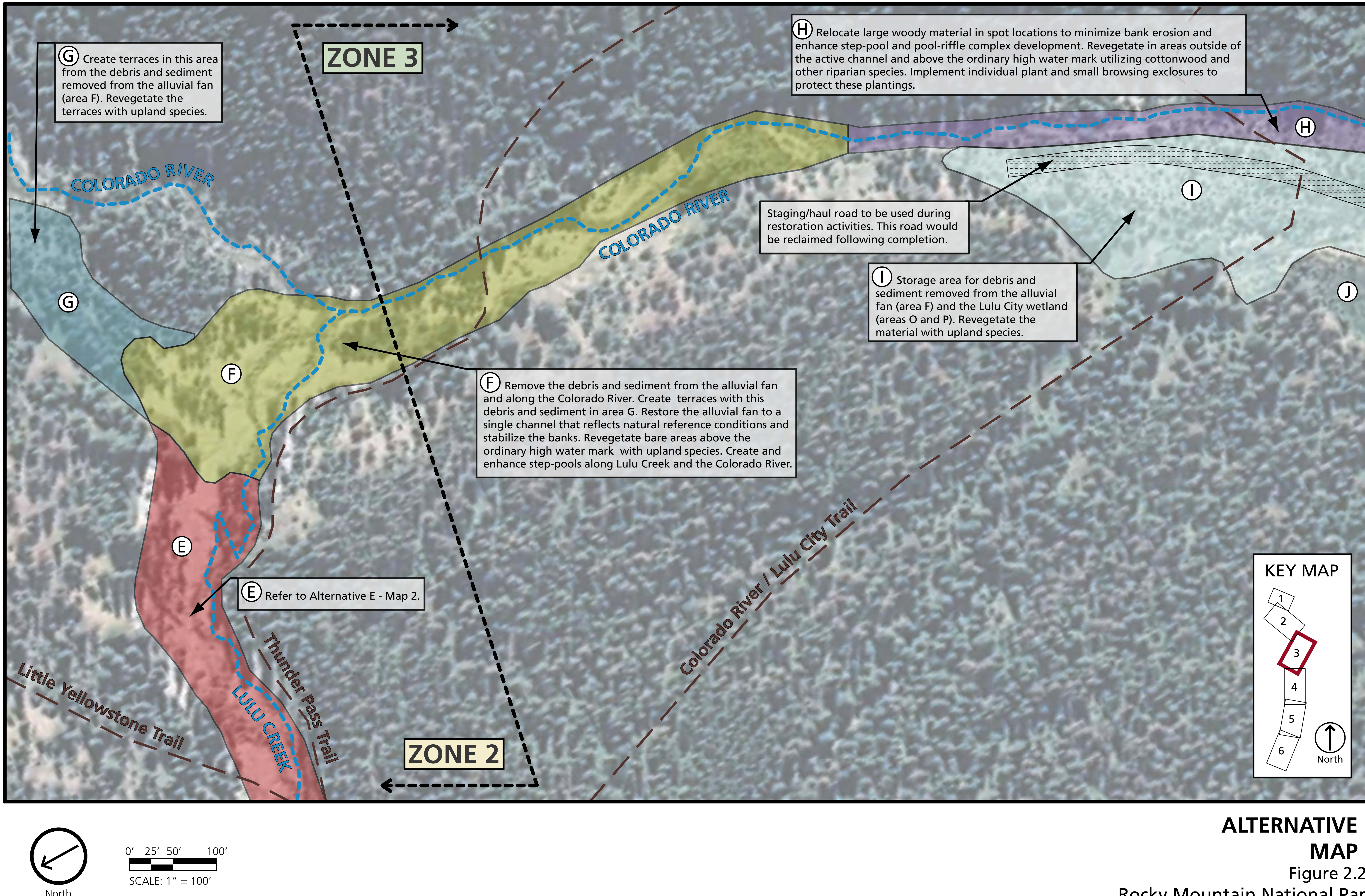

ALTERNATIVE E
MAP 3
Figure 2.26
Rocky Mountain National Park
United States Department of the Interior / National Park Service

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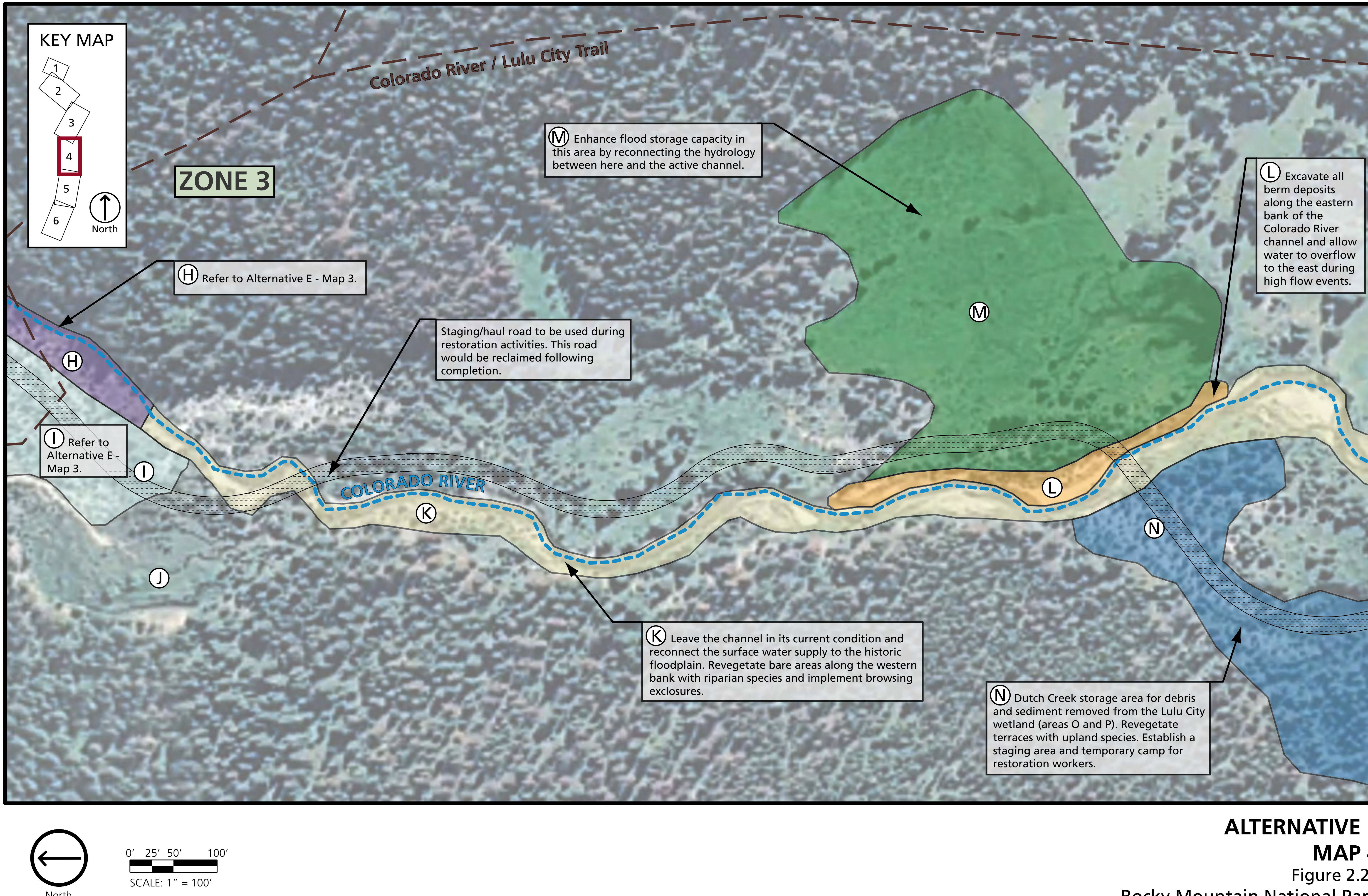

ALTERNATIVE E
MAP 4
Figure 2.27
Rocky Mountain National Park
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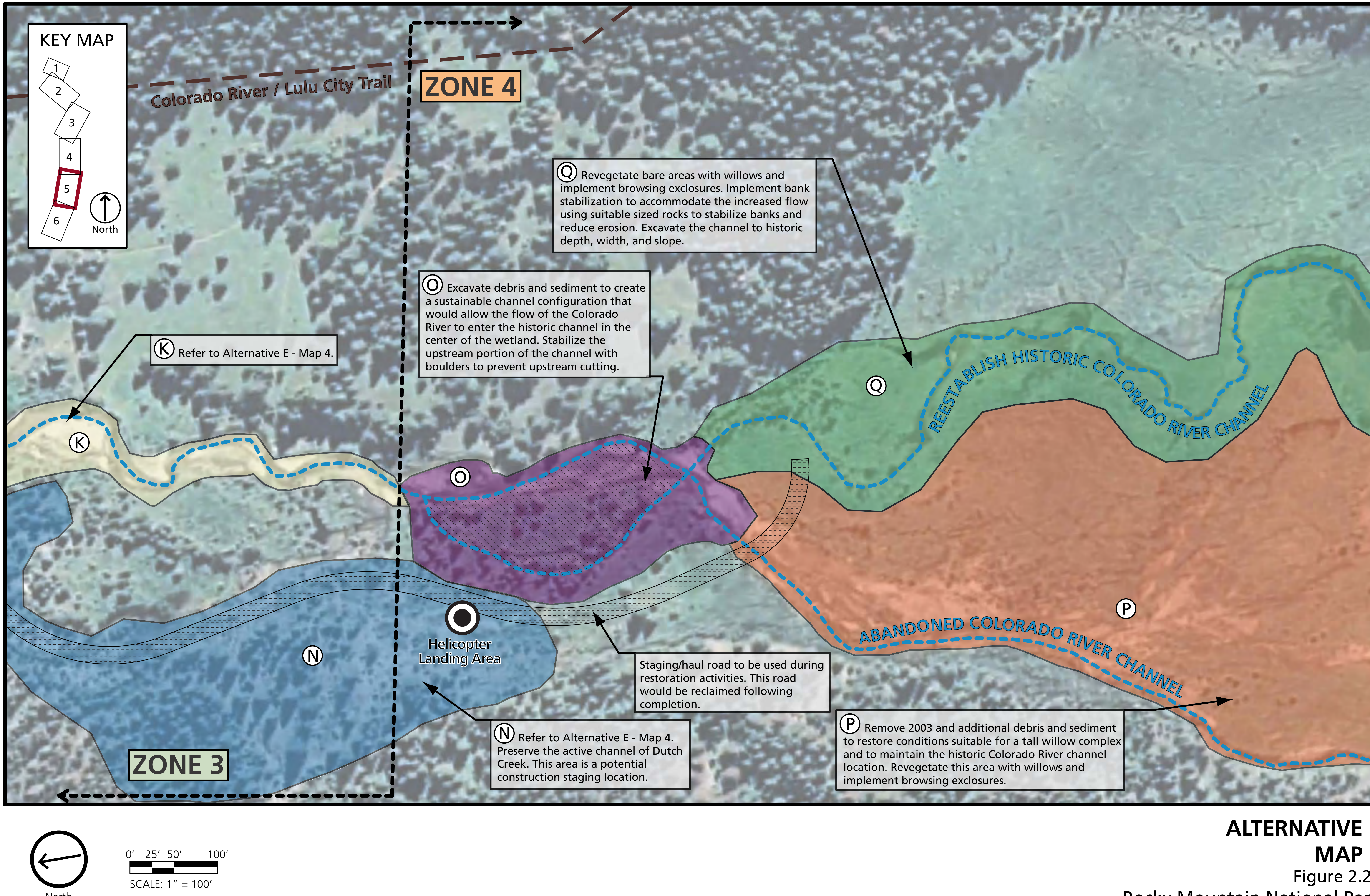

ALTERNATIVE E
MAP 5
Figure 2.28
Rocky Mountain National Park
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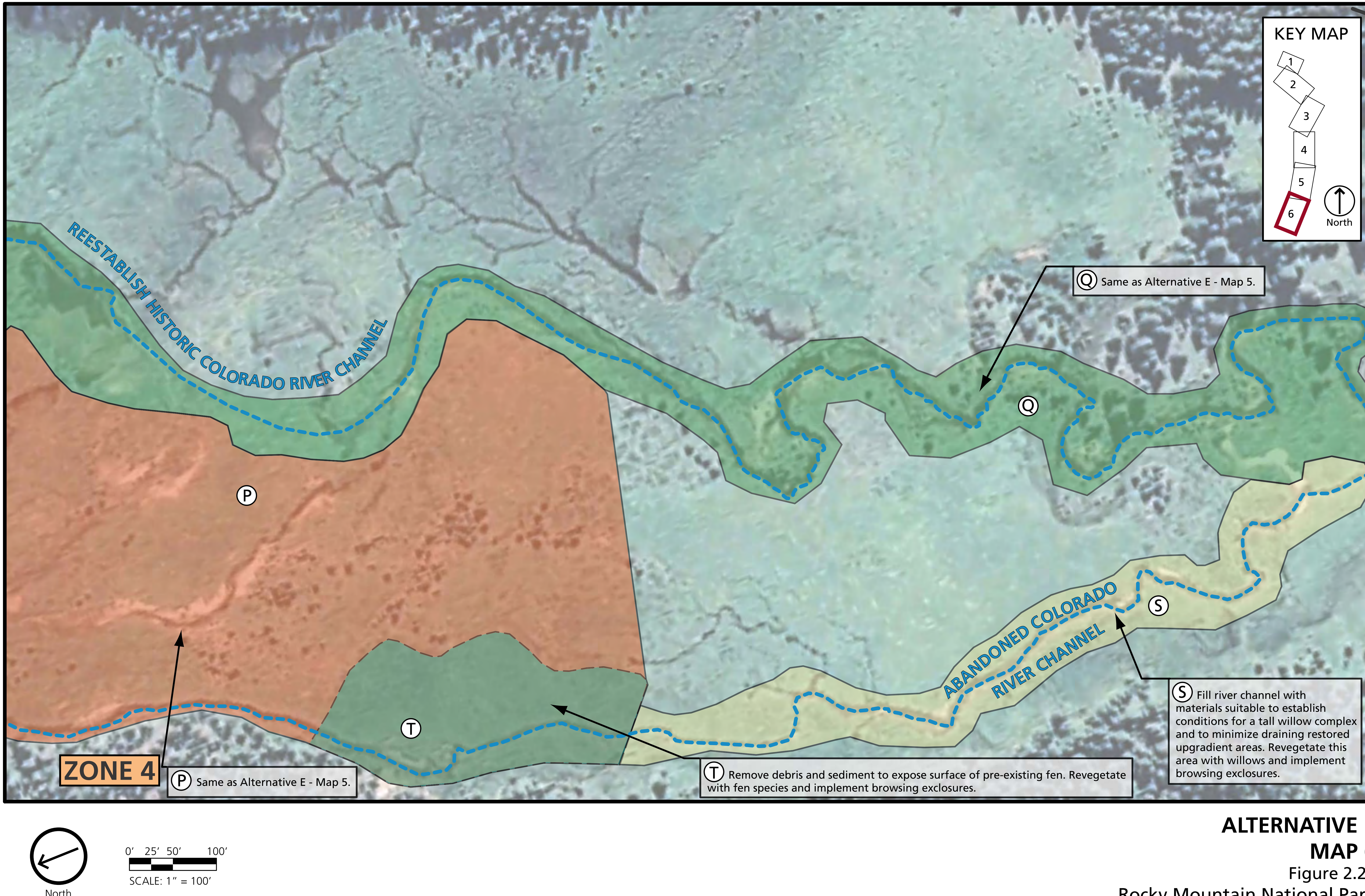

ALTERNATIVE E
MAP 6
Figure 2.29
Rocky Mountain National Park
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CHAPTER 3:

AFFECTED ENVIRONMENT

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INTRODUCTION

This chapter describes the existing environment of the Grand Ditch breach restoration area in Rocky Mountain National Park. The focus is on the park's resources, visitor uses and experiences, and park operations that could be affected by implementation of the alternatives. In addition to park operations, the following resources are described in relation to the Grand Ditch: wilderness character, natural soundscape, geology and soils, water resources, wetlands, vegetation, special status species, wildlife, cultural resources, visitor use and experience. These topics were selected based on federal laws and regulations, executive orders, NPS expertise, and concerns expressed by other agencies or by members of the public during scoping for this restoration. The conditions described in this chapter establish the baseline for the evaluation of environmental consequences in chapter 4. The Council on Environmental Quality (1978) guidelines for implementing the National Environmental Policy Act requires that the description of the affected environment focus on the resources that might be affected by implementation of the alternatives. The following sections describe in detail the existing conditions of the park's resources that could be affected by implementing any of the alternatives that were described in chapter 2.

WILDERNESS CHARACTER

INTRODUCTION

The 1964 Wilderness Act defines wilderness:

> A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

The Wilderness Act, NPS *Management Policies*, and Director's Order 41, "Wilderness Preservation and Management" provide guidance for wilderness management. Policies state that "if a compromise of wilderness resource or character is unavoidable, only those actions that preserve wilderness character and/or have localized, short-term adverse impacts will be acceptable." Wilderness should be an area where the earth and its community of life are untrammeled by humans. It should retain its primeval character and influence without permanent improvements. The purpose of wilderness in the national parks includes the preservation of wilderness character and wilderness resources in an unimpaired condition (NPS 2006a).

NPS *Management Policies* also address the management of public use of wilderness and state that the NPS will "encourage and facilitate those uses of wilderness that require the wilderness environment and do not degrade wilderness resources and character." As stated in the Wilderness Act, these areas are for public purposes of recreational, scenic, scientific, educational, conservation, and historical uses. Visitors are encouraged to comply with the concept of minimum impact wilderness use.

No temporary roads, motor vehicles, motorized equipment or motorboats, landing of aircraft, other form of mechanical transport (including bicycles), and structures or installations are allowed on wilderness lands. Temporary exceptions for emergency situations are allowed. Administrative use of motorized or mechanized equipment is allowed only if (1) such use is required for management of the wilderness and (2) the equipment is the minimum required to conduct the task.

WILDERNESS IN ROCKY MOUNTAIN NATIONAL PARK

A recommendation to officially designate much of Rocky Mountain National Park as wilderness was first introduced to Congress by President Nixon on June 13, 1974. Since then, no action was taken that would diminish the wilderness suitability of the area recommended for wilderness study or for wilderness designation until the legislative process was completed. The Omnibus Public Lands Management Act of 2009 designated nearly 95% of the park as wilderness. The wilderness area contains 249,339 acres and includes the headwaters of four major river basins: the Big Thompson, North Fork of the Colorado, North Fork of the St. Vrain, and Cache La Poudre rivers. The wilderness area includes most of the park's undeveloped lands ranging in elevations from 7,860 feet in the wide, grassy valleys to 14,259 feet at the weather-ravaged top of Longs Peak. Wilderness in Rocky Mountain National Park is currently managed under the *Backcountry/Wilderness Management Plan* (NPS 2001a).

Certain conditions or uses within the backcountry/wilderness at Rocky Mountain National Park existed before the establishment of the park. These uses, through the park's enabling or subsequent legislation, have the right to continue, subject to park oversight and applicable regulations (e.g., title 36 of the *Code of Federal Regulations*) that protect park resources and values regardless of property ownership (if within the boundaries of Rocky Mountain National Park). The Grand Ditch, owned and operated by the Water Supply and Storage Company, is one of these uses. As a result, the ditch and a surrounding buffer fall outside the designated wilderness boundary. The wilderness boundary along the Grand Ditch begins from the center line of the ditch and extends horizontally 200 feet on each side of the center line for a total easement width of 400 feet. Thus, the surface distance may be greater than the horizontal distance, depending on local terrain. This boundary occurs at the transition between zone 1A and zone 1B within the project area. Figure 3.1 shows the approximate wilderness boundary and management classes in the vicinity of the breach.

In addition to the wilderness area within Rocky Mountain National Park, six wilderness areas administered by the U.S. Forest Service lie adjacent to the park, including Indian Peaks (73,291 acres), Rawah (73,068 acres), Comanche Peak (66,791 acres), Never Summer (20,747 acres), Neota (9,924 acres), and Cache la Poudre (9,238 acres). A wilderness management objective for Rocky Mountain National Park is to cooperate and coordinate the management of the park's wilderness with management of the adjacent U.S. Forest Service wilderness areas. Information, techniques, and ideas will be freely shared and discussed that will lead to better protection and management of wilderness areas administered by both agencies (NPS 2001a).

WILDERNESS BACKCOUNTRY MANAGEMENT PLAN DESIGNATIONS AND REGULATIONS

All backcountry/wilderness areas of Rocky Mountain National Park are assigned to one of four management classes based on five criteria: type and amount of use, accessibility and challenge, opportunity for solitude, acceptable resource conditions, and management use. Table 3.1 presents some of the primary characteristics associated with each backcountry/wilderness management class.

NPS policy dictates that all management decisions affecting wilderness must meet the minimum requirement concept by completing a minimum requirement analysis on potential actions in wilderness. This analysis enables managers to examine and document whether a proposed management action is appropriate in wilderness and, if it is, what is the least intrusive equipment, regulation, or practice (minimum tool) that will achieve wilderness management objectives. The completion of this process helps managers make informed and appropriate decisions concerning actions conducted in wilderness (NPS 2001a).

In wilderness, how a management action is carried out is important in addition to the end result. When determining minimum requirement, the potential disruption of wilderness resources and character will be considered before, and given significantly more weight than economic efficiency and convenience. If a compromise of wilderness resources or character is unavoidable, only those actions that preserve wilderness character in the long term and/or have localized, short-term adverse impacts will be acceptable (NPS 2001a).

Stricter standards are applied to the use of motorized equipment and mechanical transport in nonemergency actions (NPS 2001a). In class 1 areas of the park, hand tools and traditional practices are typically used. Motorized equipment and mechanical transport are not allowed except during emergency operations or when "absolutely critical" for the protection of natural or cultural resources as determined on a case-by-case basis using a minimum requirement analysis and approved by the superintendent. In classes 2, 3, and 4, hand tools and traditional practices are used whenever possible. Motorized equipment and mechanical transport are not routinely used, unless their use is first reviewed with minimum requirement analysis or approved in an existing management plan (e.g., backcountry/wilderness management plan, fire management plan). Refer to appendix F for the minimum requirement analysis for the NPS preferred alternative.

As shown on figure 3.1, the Grand Ditch breach restoration area includes primarily class 3 and class 1 areas of wilderness.

Table 3.1: Rocky Mountain National Park Wilderness Management Classes

Class	Public Use	Opportunity for Solitude	Management Use
1	Day use only; no stock use; no camping except for management activities and in winter (with restrictions)	Outstanding opportunity for solitude; natural sounds prevail	No designated or maintained trails; no signs or cairns; evidence of management is rare; mechanized equipment only during emergency operations or “absolutely critical” as determined by a minimum requirement analysis and approved by superintendent
2	Low to moderate use; no stock use; area camping for seven or fewer persons allowed; no fires	High most of the year; moderate during summer; some noise interferes with natural sounds	No designated trails, but some designated routes; minimum cairns as necessary; no facilities; signs only as needed to protect resources and public safety; no motorized equipment except when approved with minimum requirement analysis
3	Moderate to high use; designated campsites; fires in campsites only; stock use on designated trails and camp sites only	Low to high depending on time of year, day of week, time of day, weather, and other factors	Facilities (e.g., privies, hitch rails, cabins, tent pads, signs) per minimum requirement concept; designated, formally constructed trails
4	High use; stock use on designated trails only; day use only (except eight designated camp areas)	Low to moderate depending on time of year, day of week, time of day, weather, and other factors	Facilities (e.g., privies, hitch rails, cabins, tent pads, signs) per minimum requirement concept; designated, formally constructed trails

WILDERNESS CHARACTER

Wilderness character is ideally described as the unique combination of (a) natural environments that are relatively free from modern human manipulation and impacts; (b) opportunities for personal experiences in environments that are relatively free from the encumbrances and signs of modern society; and (c) symbolic meanings of humility, restraint, and interdependence in how individuals and society view their relationship to nature (Landres et al. 2008). Based on section 2(c), “Definition of Wilderness” from the Wilderness Act of 1964, four qualities of wilderness make the idealized description of wilderness character relevant, tangible, and practical to the management and stewardship of all wildernesses, regardless of size, location, or other unique place-specific attributes (Landres et al. 2008):

Untrammeled: Wilderness is essentially unhindered and free from modern human control or manipulation.

Natural: Wilderness ecological systems are substantially free from the effects of modern civilization.

Undeveloped: Wilderness retains its primeval character and influence and is essentially without permanent improvement or modern human occupation.

Solitude or Primitive and Unconfined Recreation: Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation.

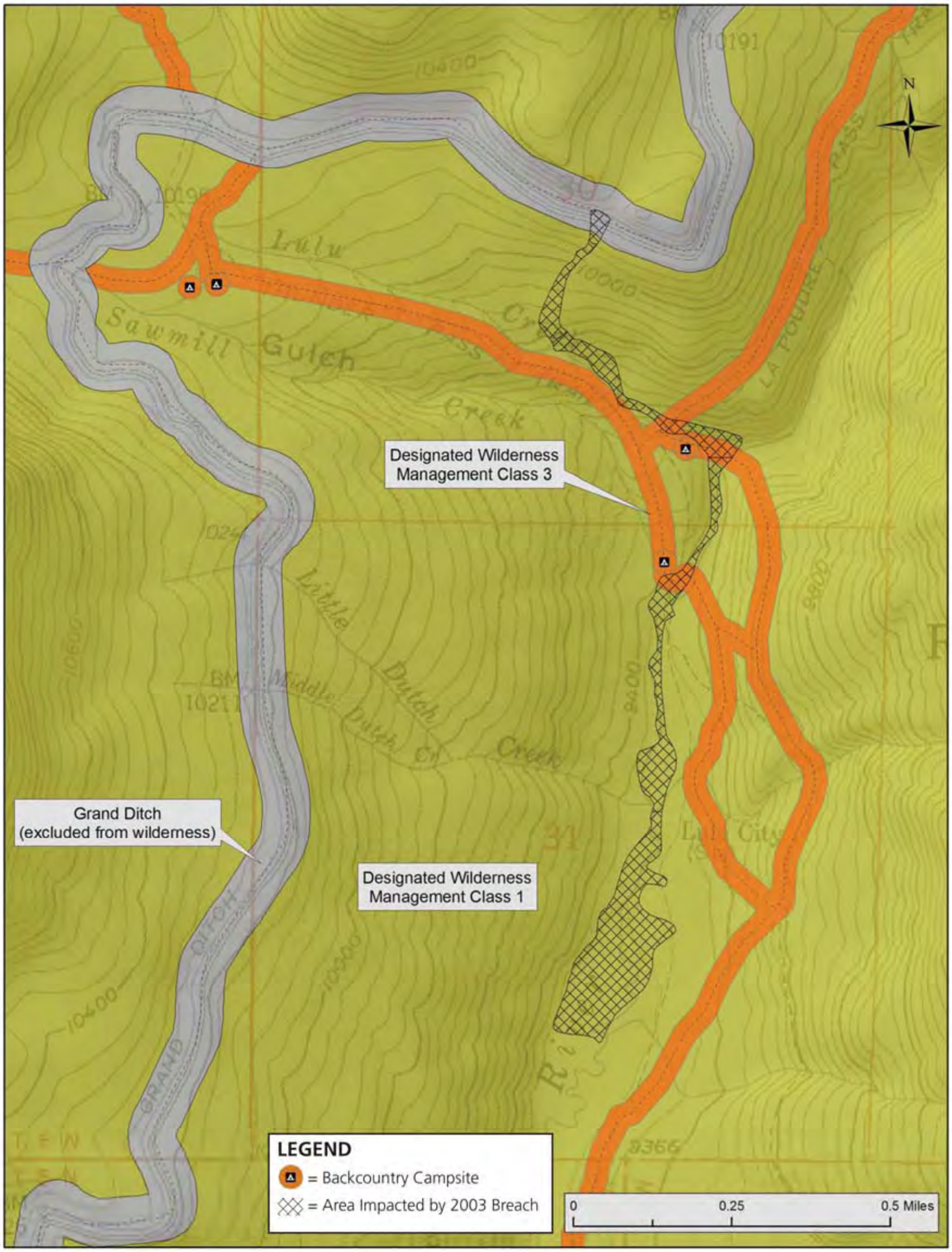


Figure 3.1: Wilderness boundary and class designations within the project area

Untrammeled

Historically, the Kawuneeche Valley has been impacted by scattered ranches and cabins, mining, and associated settlements. The remains of the 1880s mining settlement of Lulu City are within the project area.

As the Front Range population grew during the late 1800s, so did the need for water. The Grand Ditch was constructed between 1890 and 1911 to divert water from the melting snowpack west of the Continental Divide in the Never Summer Mountains toward the more settled but semiarid areas to the east. A 6-mile extension to the ditch was constructed between 1934 and 1937. By diverting runoff from the Never Summer Mountains, the ditch alters the biophysical environment within the Kawuneeche Valley.

The 2003 ditch breach resulted in damages to the character, landscape, and ecological processes within the Kawuneeche Valley. As a consequence of the 2003 breach, evidence of human alteration is present throughout the impacted area in the designated wilderness.

The alteration of ecological systems in the park infringes upon the untrammeled qualities of its wilderness. Rocky Mountain National Park has multiple plans in place to restore natural conditions to the restoration area and to the park. Some of these plans include:

- *Fire Management Plan*, 2012
- *Vegetation Restoration Management Plan*, 2006
- *Elk and Vegetation Management Plan*, 2007
- *Bark Beetle Management Plan*, 2005
- *Invasive Exotic Plant Management Plan*, 2003

These plans deal directly with altered ecological systems within the park.

Undeveloped

Much of the Never Summer Mountains portion of the Rocky Mountain National Park wilderness area is largely undeveloped. Recreational facilities within the area are discussed in the "Outstanding Opportunities for Solitude or Primitive, Unconfined Recreation" section. Due to the history of human occupation and development in the area, there are remnant structures within the historical Lulu City area; this site is on the National Register of Historic Places and is discussed in further detail in the "Cultural Resources" section. Lulu City and its historic remnants are part of the wilderness and contribute to the wilderness character within this area.

Since the 2003 breach, numerous and ongoing scientific studies have occurred within the wilderness area. Because of the unique scientific opportunity to witness the ecological and hydrological response of the area to the breach, it is expected that these scientific studies will continue in the foreseeable future. Execution of these studies has included the occasional use of small mechanized equipment and the temporary installation of measuring tools such as metering devices and wells.

As mentioned above, the Grand Ditch itself does not fall within the designated wilderness area.

Authorized mechanized uses within the wilderness area include limited trail and/or maintenance work (which would require a minimum requirements analysis) and emergencies. The park estimates that the use of authorized mechanized equipment within the area occurs once or twice annually. Except for scientific equipment mentioned above, the undeveloped quality of the wilderness within the project area was not affected by the 2003 breach.

Natural

The Grand Ditch diverts about 29% of the snow runoff from the Kawuneeche Valley north and into Long Draw Reservoir, east of the Continental Divide. This diversion of water has impacted the natural ecology and hydrological processes of the area. While spring runoff is periodically released from the ditch, the locations, volumes, and consistencies of these flows differ from what would naturally occur in the absence of the ditch. Despite the diversion of water from the Never Summer Mountains, the Kawuneeche Valley has largely supported natural ecological processes for the past 120 years. The 2003 Grand Ditch breach disrupted and altered these natural processes, resulting in conditions in the impacted area that would not otherwise be present. For more detailed information regarding natural systems and processes in the project area, refer to the sections on geology and soils, water resources, wetlands, vegetation, special status species, and wildlife.

Outstanding Opportunities for Solitude or Primitive, Unconfined Recreation

Primitive (nonmotorized) forms of recreation are allowed in wilderness. Within the Never Summer Mountains portion of the Rocky Mountain National Park wilderness area, hiking, backpacking, horseback riding, cross-country skiing, and snowshoeing are allowed. While not as frequently used as in the summer, the Kawuneeche Valley is a popular skiing and snowshoeing destination in the winter. Recreational facilities within the wilderness area include marked trails, pit toilets, backcountry campsites, and signs.

Opportunities for isolated and primitive camping experiences exist at several backcountry campsites within the Kawuneeche Valley and at two dispersed camping areas close to the project area (figure 3.1). Use of these campsites requires a backcountry permit that can be obtained from any ranger station within the park. The area is frequently used for hiking and backpacking in the summer; in 2010, backcountry campers used sites within the Kawuneeche Valley for 721 user nights. One user night constitutes one individual camping for one night (NPS 2011e).

The trails and backcountry dispersed camping areas fall within class 3 wilderness, where opportunities for solitude can be low to high depending on the time of year, day of the week, time of day, weather, and other factors. The 2003 breach had some effect on opportunities for solitude or unconfined recreation within the wilderness area through the use of equipment to repair the damaged section of the Grand Ditch and the presence of researchers and equipment to monitor the effects of the breach. Additional information is discussed in the "Visitor Use and Experience" section.

Visual evidence of development and human manipulation can impact the solitude and primitive qualities of the wilderness. Though not within the wilderness boundary, the Grand Ditch created a 14.3-mile scar on the landscape that is visible from much of the wilderness area in the Kawuneeche Valley. Visual evidence of the 2003 breach is present throughout the wilderness within the impacted area, and this evidence has altered the primitive character of the wilderness.

Human-caused sound can be an unwanted intrusion into the solitude of the park. Human-caused sounds in this part of the park are usually confined to trails and campsites. There are no roads in the area except for the ditch road, which is restricted to vehicular access by the Water Storage and Supply Company to service and monitor the ditch during the spring and summer. Commercial flights above 15,400 feet fly over the park daily and may be audible from within the project area. Sound levels vary according to the season, corresponding to the number of park visitors. For more detailed information, refer to the "Natural Soundscape" section.

NATURAL SOUNDSCAPE

INTRODUCTION

The natural soundscape is an intrinsic element of the park environment. It is an inherent component of "the scenery and the natural and historic objects and the wild life" protected by the Organic Act of 1916. The soundscape is composed of the sound conditions in a park in relation to the park's significant resources and mission. At Rocky Mountain National Park, the soundscape is an aggregate of the natural and nonnatural sounds that occur in the park. This section addresses the physical properties of sound. The "Visitor Use and Experience" and "Wilderness" sections consider how visitors to the park perceive and react to sound.

NATURAL SOUNDSCAPE

Increasingly, even parks that appear as they did in historical context do not sound like they once did. Natural sounds are being masked or obscured by a wide variety of human activities. Soundscape preservation and noise management are dimensions of preserving park resources for the enjoyment of present and future generations. Natural soundscapes are valued resources at Rocky Mountain National Park.

- Section 8.2.3 of *Management Policies 2006* (NPS 2006a) states, "The natural ambient sound level — that is, the environment of sound that exists in the absence of human-caused noise — is the baseline condition, and the standard against which current conditions in a soundscape will be measured and evaluated."
- Section 4.9 requires that "The National Park Service will preserve, to the greatest extent possible, the Natural Soundscapes of parks … [and] will restore to the natural condition wherever possible those park soundscapes that have become degraded by unnatural sounds (noise)."
- Some human-caused sound is considered acceptable when associated with purposes and uses for which the park was created. Director's Order 47 (NPS 2000) and *Management Policies* Section 4.9 (NPS 2006a) require park units to determine the level of human-caused sound that is necessary for park purposes and to achieve that level by reducing noise and restoring the natural soundscape to the greatest possible extent.

ACOUSTICS PRIMER

Commonly Used Terms

Several acoustical terms and concepts commonly used in natural soundscape descriptions and sound evaluations are briefly defined here.

Audible: A sound that can be heard by a person with normal hearing. Not all sounds that are audible will be perceived by humans because, for example, people are not present or they are present but are not paying attention to unrelated sounds. Audibility is useful because it accounts for the sound level and frequency of both the sound source and ambient sounds.

Decibel (variously abbreviated as dB or db): A sound-level unit measured on a logarithmic scale. The "A-weighted" decibel scale (dBA) is a widely used weighting system that approximates how the human ear responds to sound levels.

Maximum sound level (Lmax): The maximum sound level of a particular event.

Natural ambient sound level: The sound level of the natural soundscape in the absence of human-made sounds.

Natural soundscape: The combined sounds of nature that exist in the absence of human-made sounds, also sometimes called natural quiet. The natural soundscape, however, is not usually quiet but includes all natural sound sources such as waterfalls, birds, thunder, and many others. The natural soundscape is the natural ambient sound level of a park.

Noise: Unwanted or extraneous sound. Noise may vary in character from day to night and from season to season. Noise intrusions have two dimensions: duration and the decibel level relative to the natural soundscape (Miller et al. 2001).

Sound can be perceived as noise because of loudness, pitch, duration, occurrence at unwanted times or from unwanted sources, or because it interrupts or interferes with a desired activity. A sound that is considered neutral or desirable by one person may be considered unpleasant noise by another person who perceives it as inappropriate, a disturbance, or having unwanted content or meaning. Noise can adversely affect park resources or values, including but not limited to natural soundscape, wildlife, and visitor experience. It can directly impact them by modifying or intruding upon the natural soundscape, masking the natural sounds that are an intrinsic part of the environment.

Percent of time audible: The percent of the total period that sound is audible.

Time above 60 decibels (TA60): The total time that sound levels are above 60 dBA. This is the sound level of a normal conversation at 5 feet, and a level that would likely cause speech interference.

Characteristics of Sound

Sound is a physical phenomenon consisting of minute vibrations of pressure that travel through a medium such as air or water. Although the decibel (dB) is the standard unit for measuring noise levels, for this discussion, the human-receptor-weighted values of dB(A) are used to describe potential effects on the park's soundscape.

Most sounds consist of many air pressure frequencies. Because the human ear is not equally sensitive to all frequencies, several frequency-weighting strategies have been developed that approximate how the human ear responds. The dBA scale is the most widely used. For most people:

- A 1-dBA change is just perceptible
- A 5-dBA change is clearly perceptible
- A 10-dBA change is perceived as being half or twice as loud

Sound levels decrease as the distance between the sound source and the receiver increases. Generally, sound levels decrease by about 6 dB with every doubling of distance from a source. Therefore, when the sound level of a source is specified, the distance from the source also must be given.

Because the decibel scale is logarithmic, individual sound levels from different sound sources cannot be added arithmetically to give the combined sound level of the sources.

- Two sound sources that produce equal sound levels will produce a total sound level that is 3 dBA greater than either sound alone.
- When two sound sources differ by 10 dBA, the total sound level will be 0.4 dBA greater than the louder source alone. Therefore when sound sources differ by more than 10 dBA, the quieter sound level can essentially be disregarded when calculating the total sound level. However, sources with dissimilar spectral characteristics may still be distinguishable even if

their sound levels vary by more than 10 dBA (for example a high-pitched, 35-dBA bird song may be audible near a road with a 50-dBA sound level composed of mostly low-frequency vehicle sounds).

Normal conversation is typically between 44 and 65 dBA (people speaking approximately 3 to 6 feet apart). Noise levels in a quiet rural area at night are typically between 32 and 35 dBA. Quiet urban nighttime noise levels range from 40 to 50 dBA. Noise levels during the day in a noisy urban area may be as high as 70 to 80 dBA. Table 3.2 depicts sound levels for common noise sources (FAA 2005).

Table 3.2: Sound Levels for Common Situations

Reference Sound	dBA Level
Whispering at 5 feet	20
Quiet residential area	40
Distant bird calls	45
Light traffic at 100 feet	50
Normal conversation at 5 feet	60
Helicopter landing at 200 feet	80
Heavy surf at 3 feet	107

SOUNDSCAPE AT ROCKY MOUNTAIN NATIONAL PARK

The natural soundscape at Rocky Mountain National Park includes sounds produced by such sources as wind, thunder, insects, bird and animal calls, falling rocks, streams, and waterfalls. One distinctive element of the park's natural soundscape is the bugling of bull elk that can be heard throughout the park during late summer and fall.

In 2005, commercial aircraft flights flying between 15,400 and 19,000 feet over the park ranged between 30 to 70 daily (NPS 2005b). In 2012, the FAA implemented a new flight route and descent path for commercial aircraft over the park that passes more directly over the project area. Federal Aviation Administration special flight rule No. 78 temporarily banned the use of low-flying, commercial air tours over Rocky Mountain National Park in 1997 (FAA 1997). Commercial air tour operations over Rocky Mountain National Park were permanently banned by the National Parks Air Tour Management Act of 2000.

In 1998, data collection was started for a study plan to characterize ambient sound and noise characteristics in the park with respect to noise from aircraft tour overflights. However, because section 806 of the National Parks Air Tour Management Act of 2000 permanently banned commercial air tours over the park, the study was suspended after phase I. The 1998 data were the first noise data collected in the park. One-hour sound level measurements were taken at eight sites by Harris Miller Miller and Hanson Inc., on one to three occasions each, in forest, tundra, and meadow habitats. Background level measurements were determined, and then intrusions from jets, other aircraft, and other human-based noises were noted. Background sounds in forested areas ranged from 25 dBA for wind to 46 dBA for elk and from 26 dBA (wind) to 38 dBA (other animals) in meadow areas (Harris Miller Miller and Hanson Inc. 1998).

Portions of the project area are adjacent to Lulu Creek and the Colorado River. Ambient noise levels near the creek and the river fluctuate across seasons due to changes in flow volumes. While noise data have not been collected within the project area, data collected along similar stream and river conditions in Grand Teton National Park indicate an ambient sound level ranging up to 69 dBA during runoff (NPS 2010b).

One-hour sound level measurements of 15 sites in Rocky Mountain National Park, taken to examine how to measure noise intrusions in national parks, provide additional baseline data with which to estimate the natural and current soundscapes of the park (Miller et al. 2001). Some undeveloped sites where wind in the foliage was heard were as low as 20 to 30 dBA. At developed sites, intrusions into the natural soundscape occurred, including low levels of traffic noise (25 to 35 dBA), helicopter overflights (50 to 73 dBA), propeller aircraft (55 dBA), and jet overflights (35 to 50 dBA).

Noise levels vary between day and night; because human activity in the park mostly occurs during the day, noise levels in the park are higher than at night. Night provides greater opportunity to experience the natural sounds in the park with less human influence.

The Grand Ditch breach restoration area is undeveloped and falls predominantly within designated wilderness. There are no roads, developed campgrounds, or private motorized vehicle use within this area. However, an access road lies outside of the wilderness boundary along the Grand Ditch. During spring and summer, the road is used daily by the Water Supply and Storage Company personnel to monitor and service the Grand Ditch. Vehicular use of this road is limited to one or two vehicles, which is not considered a significant source of noise. Trail Ridge Road is approximately 1.5 miles south of the area and may be audible during peak visitation in the summer months, especially when motorcycles with tuned pipes pass along the road. The primary human-made sounds in the project area are noises associated with trails and campsite use. Human-caused sound is typically higher between May and September, corresponding with higher park visitation during these months.

GEOLOGY AND SOILS

GEOLOGY

Mountains in Rocky Mountain National Park were formed by a series of granitic batholiths intruded into Precambrian mica schists and pegmatites. Igneous and metamorphic rock and glacial till generally characterize the geology of the park. Elevations within the Rocky Mountain National Park range from 8,000 to over 14,000 feet, and nearly one-third of the park lies at an elevation of over 11,000 feet (NPS 2001a). Glacial activity, occurring as recently as 12,000 years ago, has created much of the geologic landforms evident in the park today by scouring the mountains. Glacier-carved valleys and their associated features are present along the St. Vrain River, Big Thompson River, Colorado River, and associated tributaries. For example, Moraine Park is the remnant of a glacial lake formed by the Thompson Glacier, and the fine sediments deposited in the lake now support wetland and grassland meadows. Moraines result from the scouring action of glaciers and are composed of unconsolidated rock and debris such as boulders, cobbles, gravel, sand, and clay. Ultimately, the weathering of the glacial and alluvial granites, schist, and gneiss parent material developed soils in the park (USDA, Natural Resources Conservation Service 2000).

The Continental Divide bisects the Rocky Mountain National Park generally from north to south, and acts as a border between two geologic areas on the east and west sides of the Park. The western side of the Park is characterized by gradual slopes that recede into the Kawuneeche Valley (NPS 2001a).

Based on the U.S. Geological Survey geologic map of the Estes Park 30' x 60' quadrangle (Cole and Braddock 2009), Paleoproterozoic metamorphic rocks are evident within zone 1, and surface again downstream. This particular outcrop is composed of biotite schist and gneiss and forms a part of the Lulu Creek stream channel in zone 2. Glacial till of Pinedale age is present along both sides of Lulu Creek (zone 2), as well as along the west side of the Colorado River. Post-Laramide volcanic rocks, undivided (upper Oligocene), and described as complexly interlayered volcanic-flow rocks and volcanic rich sedimentary rock, are present in zone 1. Holocene and upper Pleistocene alluvium, composed of sand, silt, and gravel, dominate in the Colorado River and associated wetland complexes in zones 3 and 4.

Cole and Braddock (2009) describe the Colorado River fault zone in which the project area occurs.

> The upper Colorado River drainage north of Grand Lake is a conspicuously linear feature that trends nearly due north for a distance of about 17 miles to the site of abandoned Lulu City. The glaciated floor of the Kawuneeche Valley exposes widespread brecciation, silicification, and iron-oxide mineralization in shattered Proterozoic rocks that indicate a substantial brittle fault zone (Braddock and Cole 1990). The fault zone has only been mapped in the lower parts of the valley and it does not continue northward through the Oligocene volcanic rocks of the Braddock Peak intrusive-volcanic complex that cap Thunder Mountain, Lulu Mountain, and Iron Mountain (north and northwest of the project area). Rather, the fault zone appears to turn northwestward and splay into smaller breccia zones that feather out.

Rock falls and debris flows are fairly frequent in mountain canyons and are most common during the spring and summer months when rainfall and snowmelt raise the local water table, increase soil pore-water pressure, and allow unstable rock masses to slide and fall. Debris flows have occurred on several occasions as a result of elevated pore-water pressure near water-conveyance systems, including the Grand Ditch. According to Cole and Braddock (2009), "several debris flows appear to have originated just below the ditch, causing water-charged rock and mud to cascade down the lower slopes of the Never Summer Mountains to the Kawuneeche Valley below."

SOILS

Soils within Rocky Mountain National Park

In 1998, an Order 2 soil survey was completed in the lower elevations of the park and an Order 3 soil survey was completed for other areas of the park. (Order 2 surveys represent a standard soil survey usually done at the county level. Order 3 surveys are less detailed than Order 2 and are often prepared primarily based on remote sensing). The following general soil properties of the park were reported (USDA, Natural Resources Conservation Service 2000).

- The igneous parent materials have generated soils that are generally coarse grained (more so in the steeper upper zones) and are highly to moderately permeable.
- Soils of the low elevation valleys are generally very deep, loamy, and formed in alluvium from the nearby mountains. In the floodplains, soils are poorly or very poorly drained with stratified textures. On stream terraces, soils are typically well drained.
- Soils of the glacial moraines are very deep, well or somewhat excessively drained, and loamy or sandy with a high rock fragment contents. They formed in till derived mainly from granite, gneiss, and schist.
- Soils of the subalpine mountain slopes are generally well or somewhat excessively drained, loamy with a high rock fragment contents, and have light-colored surface horizons. Depth to the underlying bedrock ranges from shallow to very deep. Typically, soil reaction becomes more acid with increasing elevation as the climate becomes cooler and moister. These soils formed mainly in material weathered from granite, gneiss, and schist.
- Soils of the alpine mountains and ridges are generally well drained, loamy with a high content of rock fragments, strongly acid, and have dark-colored surface horizons. These soils formed mainly in material weathered from granite, gneiss, and schist. Poorly drained soils are common in landscape depressions and drainages.

Soils within the Project Area

Based on the 1998 soil survey, the following soils occurred in the project area before the breach (California Soil Resource Laboratory 2008). Capability classes, such as limitations because of erosion, are defined in the *National Soil Survey Handbook* (USDA, Natural Resources Conservation Service 2011a).

- Zone 1 – Soils in this zone consist of a Fallriver-Hiamovi complex, with a 10 to 55% slope. The slope at the breach area is estimated to be 35% (Rathburn 2007). Parent materials are colluvium and till and residuum derived primarily from extrusive igneous basalt and andesite, with some contribution from metamorphic gneiss and schist. The area is somewhat excessively drained, and runoff is very high. Erosion is the dominant problem or factor affecting the use of these soils, and represents a very severe limitation that restricts recommended uses to grazing, forest land, or wildlife.
- Zones 2 and 3 – Soils in these zones are characterized by a Hiamovi-Rock outcrop complex, with 15 to 80% slopes. Hiamovi soil series are a gravelly slope alluvium or residuum weathered primarily from extrusive igneous basalt and andesite, with some contribution from metamorphic gneiss and schist. The soils are somewhat excessively drained. Approximately 30% of the area is rock outcrops. The Hiamovi soils component has very severe limitations because of erosion that restrict recommended uses to grazing, forest land, or wildlife.

- Zone 4 – Soils are characterized by Kawuneeche mucky peat, with a 0 to 4% slope. Parent material is alluvium over sandy and gravelly glacio-fluvial deposits derived primarily from extrusive igneous basalt and andesite, with some contribution from metamorphic gneiss and schist. This area is poorly drained floodplain and the average depth to groundwater is 12 inches in areas where the native soil is not buried by sediment deposits. Excess water is the dominant limitation affecting their use, including poor soil drainage, wetness, and a high water table. As a result, they have severe limitations, and recommended uses are limited to pasture, range, forestland, or wildlife food and cover.

Other soils found along the periphery of the project area include relatively small areas of Enentah very stony loam on 10 to 40% slopes, Fallriver gravelly sandy loam on 10 to 45% slopes, and Fallriver gravelly sandy loam, warm, on 10 to 45% slopes. These soils comprise less than 1% of the project area.

Soil Diversity. Site investigations by Cooper and Potter (2009) indicate that soils in the project area are complex. Soil profiles demonstrate a wide variety of subsurface layers (peat, sand, clay, gravel, and cobble) in different order at different locations. Table 2.2 in the "Alternatives" chapter presents the soil textures present within each of the zones. These profiles demonstrate that many forces have acted on the soil system in the project area over many years. This is common in riparian areas where streams often meander from one side of the valley to the other responding to changes in flows, sediment loads, and other debris. Riparian soils are also influenced by animals such as beaver, and the soils in the project area have likely also been influenced by early prospecting and mining that started in the mid- to late-1800s (NPS 2004b).

Erosion and Deposition. The Grand Ditch Breach in 2003 created major areas of erosion in zones 1 and 2, and substantial deposition in the lower portion of zone 2, as well as in zones 3 and 4. More detail for each zone is provided below. The values presented below are based on original estimates taken before 2009; since then, the high spring runoffs of 2010 (a 30-year flow event) and 2011 (a 60-year flow event) have transported additional sediment from zones 2 and 3 into zones 3 and 4 and have further changed the previous 2009 estimates. Estimates of what is currently present are not yet available.

Erosion – Zones 1 and 2 (Upper Portion) – During the breach, debris flow removed all vegetation and incised a deep channel in the soil in zone 1, exposing the deep soil matrix with embedded cobbles and boulders. Approximately 47,600 cubic yards of sediment and debris were eroded from upper zone 1. The slopes in zone 1 are unlikely to remain stable in the long term and may ultimately erode away (Telesto Solutions Inc. 2007). This zone includes an eroded gully created by the breach and the adjacent forested hillside below zone 1. It is estimated that only 50% of the herbaceous cover of the area would recover naturally over 150 to 200 years.

In lower zone 1, enough soil was removed during the breach to expose portions of the groundwater, creating a small tributary to Lulu Creek near the bottom of zone 1. In the gully above this tributary, raveling and settling of the gully banks and bottom are ongoing. It is estimated that only 50% of the herbaceous cover of the area would recover naturally over 150 to 200 years. Complete recovery of the natural forest to pre-breach conditions would not occur due to the drastic change in slope and the loss of soil in the area, such that only rock remains (Cordova 2006).

In zone 2, breach-related erosion removed soils to a depth of up to 6 feet and widened the stream channel between 2- and 10-fold (Rathburn 2007). As a result of the breach, preexisting landforms, hydrologic regime, and vegetation in this zone were impacted, and there has been a change in step-pool bedforms. Step pools dissipate flow energy, especially during floods, and reduce their erosional nature. In areas along the creek, the banks consist of unconsolidated alluvium; these are devoid of soil and are unstable.

Deposition – Zone 2 (Lower Portion), and Zones 3 and 4 – In zone 2, the 2003 breach deposited roughly 23,500 cubic yards of poorly sorted boulders, cobbles, sand, and other debris in the main stream channel and the alluvial fan where Lulu Creek joins the Colorado River. Materials in the fan account for a little less than half the total. Although much of the deposit is barren, vegetation is apparent in the pockets of sand and mineral soils among the rocks. The new deposits along the banks of Lulu Creek are easily mobilized and are a source for downstream deposition. Sediment and debris deposits in the alluvial fan are up to 6 feet thick and provide a source of downstream sediment and debris even at lower flows (Rathburn 2007).

In zone 3, approximately 13,800 cubic yards of material were deposited in Colorado River channel, primarily in low areas like channel pools and wetlands. Deposits of gravel and cobble bars exist along the entire zone as a result of the breach, with abundant debris jams formed from trees and logs. These debris dams contain large quantities of fine- to coarse-grained material (Rathburn 2007). These areas represent sources of future sediments. Zone 3 also contains debris deposits that resulted from other unnatural debris flows and natural slope failures that occurred before the 2003 breach. These old debris deposits modified the river channel, water direction, and physical channel dimensions. The old debris deposits are in various states of natural forest, wetland, and grassland revegetation."

In Zone 4, the Lulu City wetland, approximately 14,000 cubic yards of material were deposited, ranging in depth from less than an inch to more than 3 feet thick. The thickest deposits are in the alluvial fan where the Colorado River enters the northern portion of the wetland (Potter 2010a).

WATER RESOURCES

This section addresses three closely interrelated aspects of water resources: hydrology, stream channel morphology, and water quality. Each aspect is described separately.

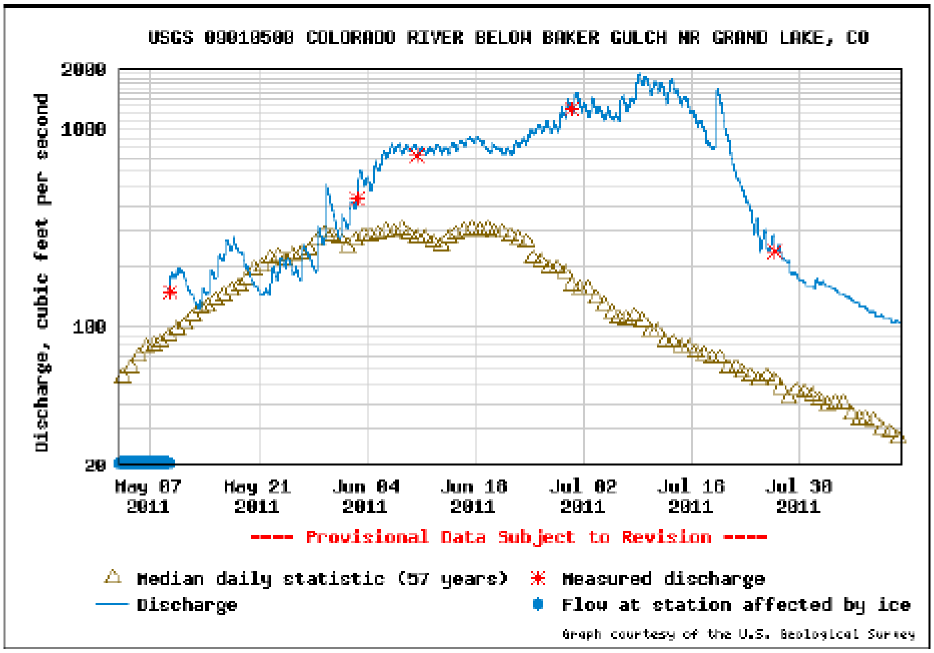
HYDROLOGY

Rocky Mountain National Park contains 1,143 acres of lakes and ponds, with 167 lakes greater than 1 acre and 397 less than 1 acre. Streams in the park total 532 miles, with an additional 38 miles of intermittent streams. The Continental Divide bisects the park into two distinct watersheds; water flowing west drains into the Colorado River, and water flowing east ultimately empties into the Missouri and Mississippi Rivers. The headwaters of four major river basins originate in the park: the Big Thompson, North Fork of the St. Vrain, Colorado, and Cache la Poudre rivers. Of these, only the Colorado River is in the project area. In addition, Lulu Creek and Sawmill Creek are included for discussion. Figure 1.5 shows the project area's streams and surface waters.

Colorado River

The Colorado River is the major stream flowing through the project area. After originating from a small complex of groundwater discharge sources southwest of Long Draw Reservoir about 2 miles upstream of its confluence with Lulu Creek, it flows south through the project area, into the Lulu City wetland complex. South of the Lulu City wetland, the river flows south about 27 river miles, passing through the Kawuneeche Valley before finally emptying into the south end of Shadow Mountain Lake near Grand Lake, Colorado. The river channel width ranges between 15 and 25 feet wide in the project area. The lowest average monthly flow occurs in February (about 7.4 cubic feet per second), and the highest average monthly flow occurs in June (about 309 cubic feet per second). Between 1953 and 2010, the mean annual discharge was 62.7 cubic feet per second, the lowest annual average discharge was 26.3 and 26.4 cubic feet per second (1954 and 2002, respectively), and the peak streamflows were 976 and 975 cubic feet per second (June 1957 and June 2010, respectively) based on flow measurements obtained from the U.S. Geological Survey Baker Gulch gaging station (USGS 2011). Provisional 2011 flow measurements reported for mid-July 2011 at this station were approximately 2,000 cubic feet per second (highest reported discharge on record), which reflects runoff from the high snowfall reported for this area during the winter of 2010–2011. This gage is about 7.8 straightline miles or 13.3 river miles downstream of the south end of the Lulu City wetland.

The annual flow regime is dominated by snowmelt, with marked daily fluctuations in flow during the melt period. The low flow period occurs in late winter and early spring before the start of snowmelt. The 57-year average and the spring 2011 above-average snowmelt runoff hydrographs at the Colorado River Baker Gulch gaging station are shown on figure 3.2. The Baker Gulch station flows indicate the relative peak, average, and low flow relationships in the project area. The project area flows would be smaller because of its location upstream of the gage station. Indications of the capability of snowmelt runoff to erode and transport sediment, especially during the high 2011 runoff season, are illustrated by figures 3.3 and 3.4. Figure 3.3 shows the Lulu Creek trail footbridge washed out and partially buried by sediment that was transported downstream from the 2003 breach. Figure 3.4 illustrates sediment transported by the runoff into the former Colorado River channel that buried the footbridge at that location. The river channel was formerly under the footbridge, which is visible in the background. Sediment deposits 3 to 6 feet deep were formed during spring runoff and came from 2003 sediment deposited in the lower Lulu Creek alluvial fan. These dramatic and rapid changes in channel location during high flow conditions are examples of avulsion. They occurred in zones 2, 3, and 4 as are discussed later as part of stream channel morphology.



Source: U.S. Geological Survey 2011

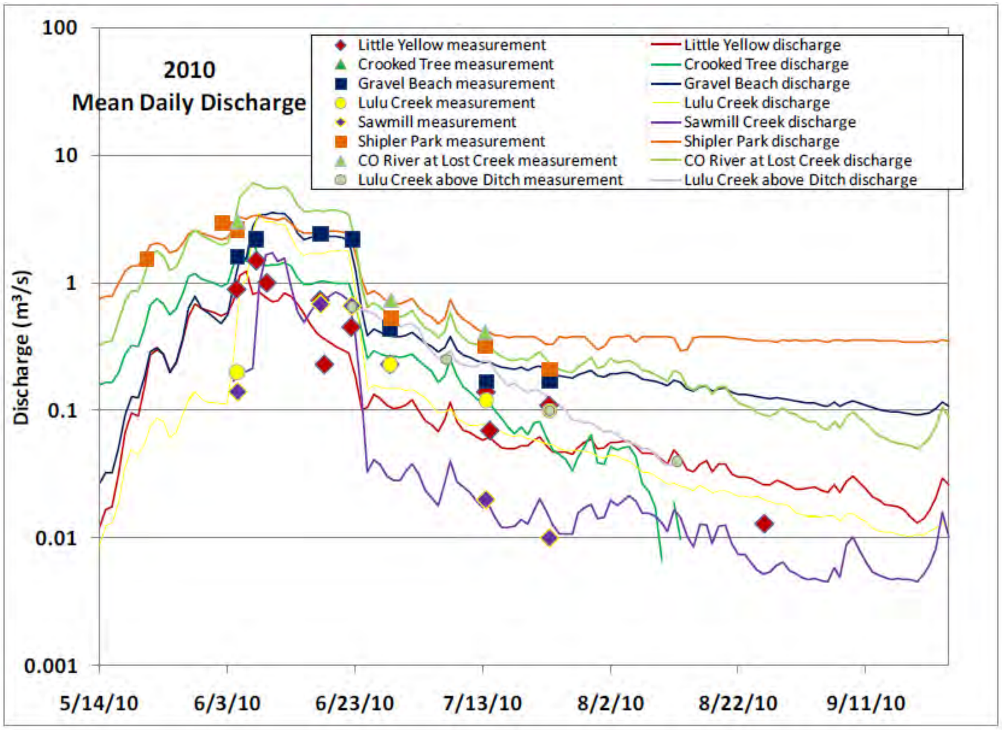
Figure 3.2: Snowmelt period hydrographs for the Colorado River at Baker Gulch comparing the long-term period of record (1953 to 2011) to 2011

From its confluence with Lulu Creek, the Colorado River flows south into the Lulu City wetland, where it splits into several channels that meander through the wetland. One primary channel follows the west side of the wetland, and another courses through the middle of the wetland. Smaller channels branch from these channels across the wetland, encouraging floodflow retention, sediment deposition, and surface water infiltration during the spring runoff period. Sawmill Creek joins the Colorado River from the west downstream from the Lulu Creek confluence, and Little Dutch Creek joins the Colorado River from the west upstream of the Lulu City wetland. Since the 2003 failure of the Grand Ditch, a series of streamflow monitoring stations were installed on the Colorado River upstream and downstream of the Lulu Creek confluence to measure changes in river flow, channel morphology, sediment bedload, and other hydrologic characteristics (Rathburn 2009, 2010, 2011a). Figure 3.5 shows mean daily flow characteristics from mid-May through mid-September 2010 for Lulu Creek, the Colorado River, and reference stations. The peak snowmelt period (mid-June) shows a rapid drop in flow due to the start of Grand Ditch diversion (about June 23), and then a gradual decline of flow through early fall (Rathburn 2011a).

Based on measurements made at these stations, eroded sediment from the breach continues to be transported downstream into the Lulu City wetland. Sediment and turbidity conditions vary with changes in river discharge. The greatest transport periods occur during the periods of highest discharge, which occur during the spring runoff during late May through mid June (Rathburn 2009, 2010, and 2011a). Because of these conditions, active channels in the floodplain change annually.

Figure 3.3: Upstream view of Lulu Creek footbridge damaged by spring 2011 snowmelt discharge redistributing 2003 breach materials (August 2011)

Figure 3.4: Upstream view of Colorado River footbridge damaged by spring 2011 snowmelt discharge (August 2011). Reworked sediment from 2003 occupies the former Colorado River channel, which is now to the left



Source: Rathburn 2011

Figure 3.5: Mean daily hydrographs for Lulu Creek, Colorado River, and other project area streams for 2010

Snowmelt in 2010 and 2011 produced the highest discharges observed in the study area since 2003, with abundant overbank flow, channel changes, wetting of the floodplain in areas that have been dry since 2003, and extensive erosion and aggradation throughout the study area (Rathburn 2011b). In all, the 2010 snowmelt generated a discharge with a 30-year recurrence interval (Rathburn 2011b). Snowmelt in the spring and early summer of 2011 was even greater than 2010, producing more intense effects than in 2010 (figure 3.2). Preliminary analyses estimated the 2011 snowmelt generated a discharge with a 60-year recurrence interval (Rathburn 2011b). This discharge washed out and buried the footbridges over Lulu Creek and across the Colorado River just downstream of its confluence with Lulu Creek (figures 3.4 and 3.5).

Lulu City Wetland

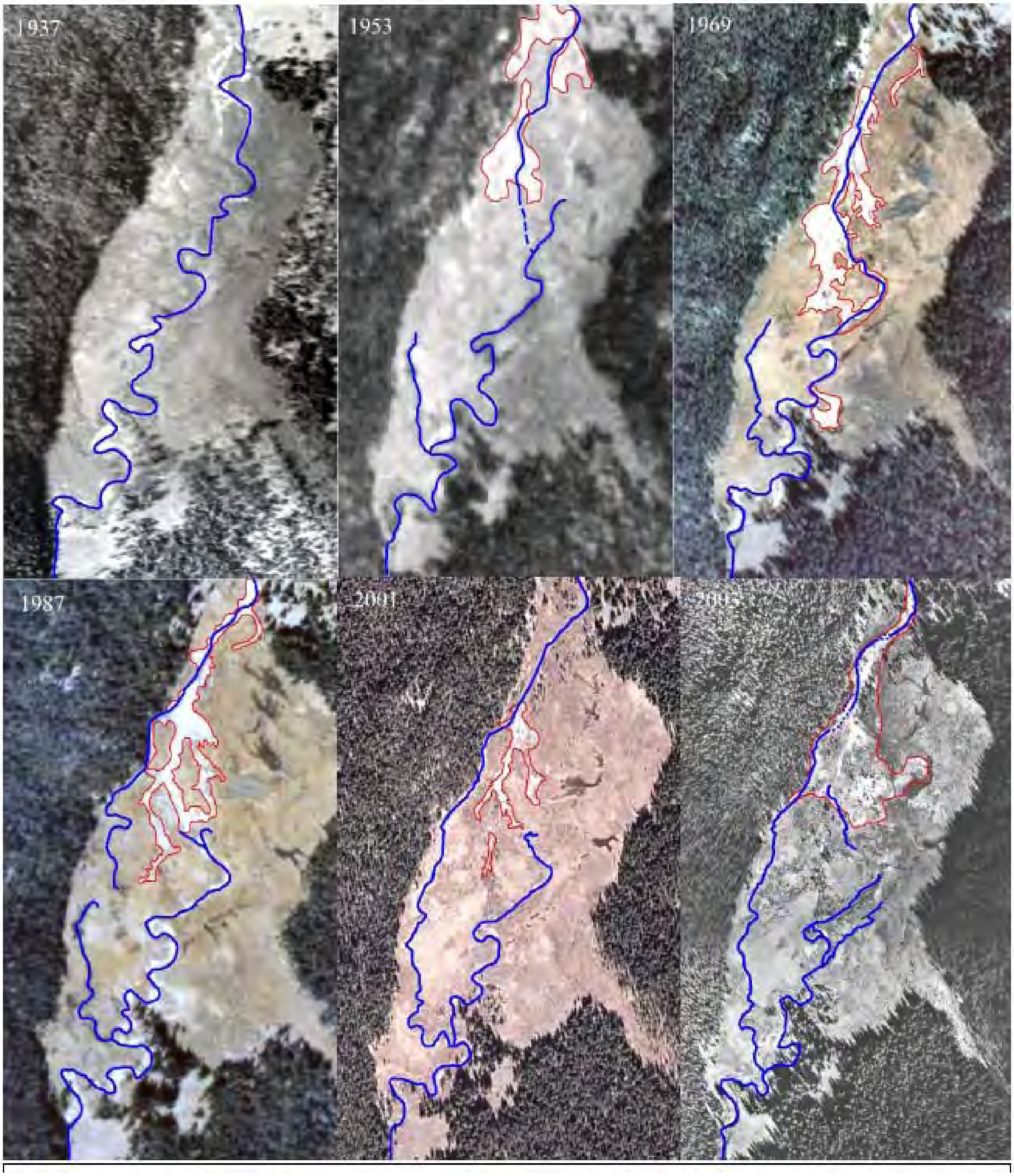
Surface water from the river flows across most of the Lulu City wetland during spring and early summer, where it partially infiltrates into permeable riverbed materials that contribute to the valley and the Lulu City wetland groundwater system. Based on groundwater investigations of Woods (2001) further south in the Kawuneeche Valley wetlands, it is likely that the groundwater system moves downgradient and south beneath the entire the Lulu City wetland, following the same path as the surface waters. Several historical meanders and cut-off oxbows in the Lulu City wetland have been created by historical debris and sediment accumulations in the wetlands (figure 3.6), leading to reduced sinuosity. Currently, the active Colorado River flow splits near the northern end of the wetland and follows both the west side of the wetland and the center of the wetland along the historical main channel. The relative volume of flow along each route varies seasonally and annually, depending on the volume and timing of snowmelt and the deposition of sediment in the channel bed.

Based on available historical aerial photography (figure 3.6), the Colorado River has progressively shifted its course from the center of the wetland to the west side of the valley due to a series of sediment flows. This shift was underway as early as 1953 as sediment deposits progressively filled in the lower central depression that previously accommodated most of the Colorado River flow. Additional sediment deposits subsequently pushed the river surface flows to lower depressions on the west side of the wetland. The Colorado River contributes both surface and groundwater to the overall water budget of the Lulu City wetland. The changes in the river channel location and alignment in the wetland from 1937 to 2003 are shown in figure 3.6. These changes occurred in response to historical sediment flows that also deposited gravel, boulders, cobbles, and sand into the wetland. The Colorado River has been predominantly located along the west side of the wetland since 1987, and possibly 1969. The Colorado River contributes water supply to the overall water budget of the Lulu City wetland.

Based on surface water and groundwater studies that were conducted on the Colorado River and its associated wetlands in and south of the proposed restoration area (Woods 2000, 2001), water supply to the Lulu City wetland comes from four primary sources: snowmelt water, Colorado River surface water, groundwater inflows from slopes on the east and west sides of the wetland, and groundwater flows following the river valley. The relative contribution of each source to the overall wetland water balance of the Lulu City wetland is currently unknown. However, based on the findings of Woods (2000), sideslope runoff could be a dominant process controlling groundwater depth and other hydrologic characteristics in the wetland. The interactions and relative importance of these four water sources in supporting the wetlands are complex and probably change in relative importance during the year and across multiple years and locations within the wetland. Surface water is generally present across the entire wetland during the spring and early summer. Depths range from 1 inch to more than 36 inches in some of the former beaver ponds that remain scattered throughout the wetland. Except in the former beaver ponds, surface water depths generally decline and disappear during the late summer and fall. However, groundwater remains close to the ground surface during this time, with depth below the ground surface varying by location within the wetland (Cooper 2009). Groundwater remains at or close to the surface near the low spots along the river channels and former beaver ponds. Surface water and groundwater flow patterns change annually in the wetland, especially in the north, where unstable sediment deposits are reworked during peak spring runoff discharges. Historical aerial photographs also demonstrate that major surface water channels in the wetland have been altered by the 2003 and earlier debris flows.

The annual and spatial changes in groundwater conditions are illustrated by the available groundwater depth and profile information that is provided in figure 3.7. Section D, which is across the Colorado River at the north end of the wetland, shows a relatively uniform groundwater depth across its entire length in both 2005 and 2008. However, in 2005, groundwater depth during the summer (June through August) was 10 to 20 inches below the surface, while in 2008 it was shallower at 4 to 10 inches below the surface. These data indicate the annual and seasonal variability in groundwater depth and distribution characteristics that will become important considerations in the future, more-detailed restoration design steps.

The changing conditions in groundwater and surface water characteristics throughout the Lulu City wetland that would affect future restoration design steps are illustrated by the water surface profiles (figure 3.7). Further downstream in the wetland, Section C reflected relatively uniform depth to groundwater conditions in both years from 4 to 10 inches below the ground surface across the entire section. Section B, which was downstream of section C, also reflected relatively uniform depths to the water in both 2005 and 2008 of about 10 inches. However, major portions of this section had surface water to depths of about 30 inches. Section A had more variable conditions between years, with groundwater ranging from 20 to 39 inches deep in 2005. Groundwater levels in 2008, however, were shallower and ranged from 4 to 20 inches deep, depending on the location. These depth differences are probably related to the mix and variety of textures and thicknesses of sediment layers.



Source: Cooper 2007

Figure 3.6: Colorado River and other stream channels (blue lines) in the Lulu City wetland in 1937, 1953, 1969, 1987, 2001, and 2003. White areas represent mineral deposits of debris and sediment.

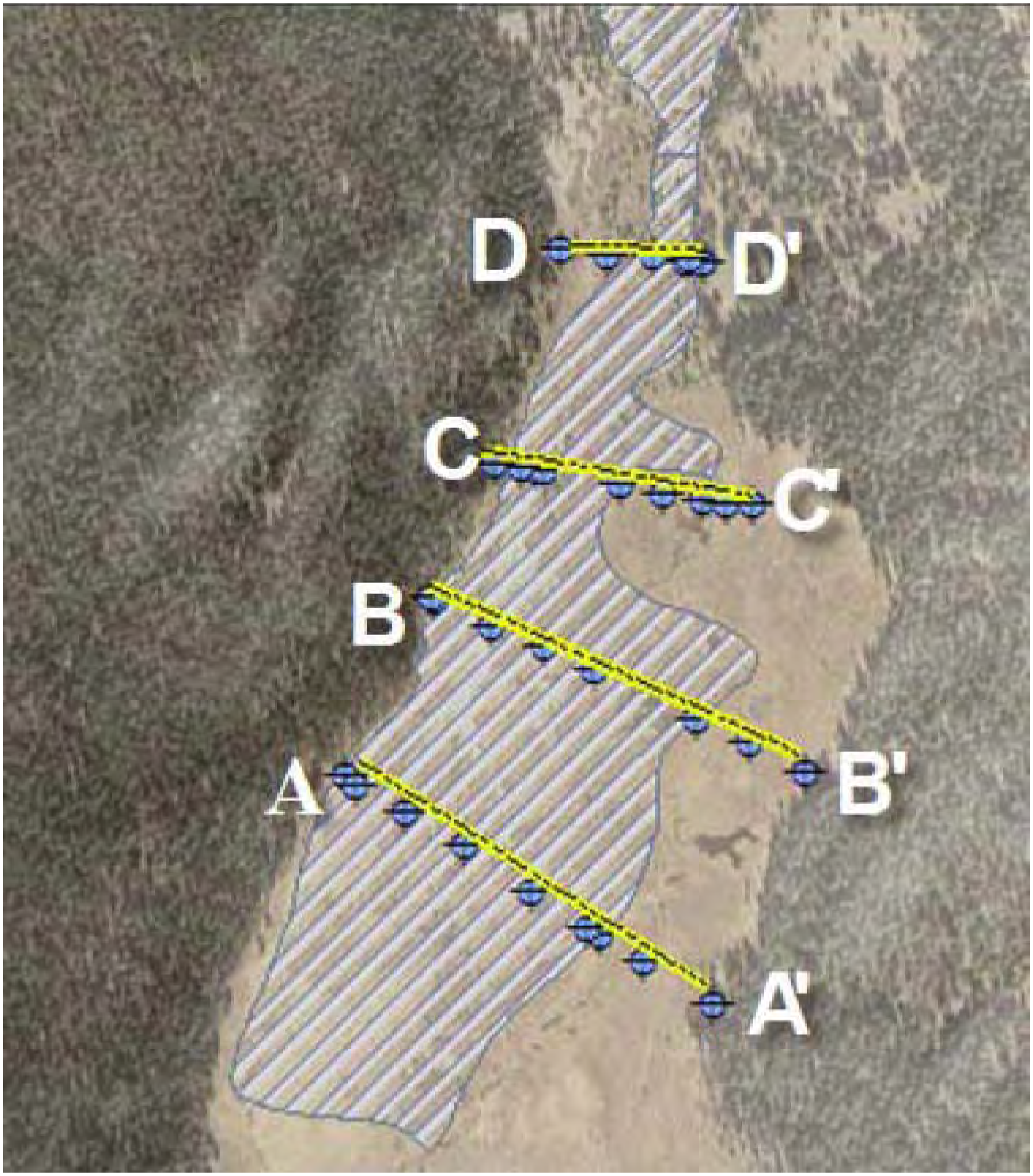


Figure 3.7a: Groundwater depths and profiles in the Lulu City wetland were measured at four cross sections in 2005 and 2008. Section D is the Colorado River upstream of the wetland, and section A is about midway through the wetland.

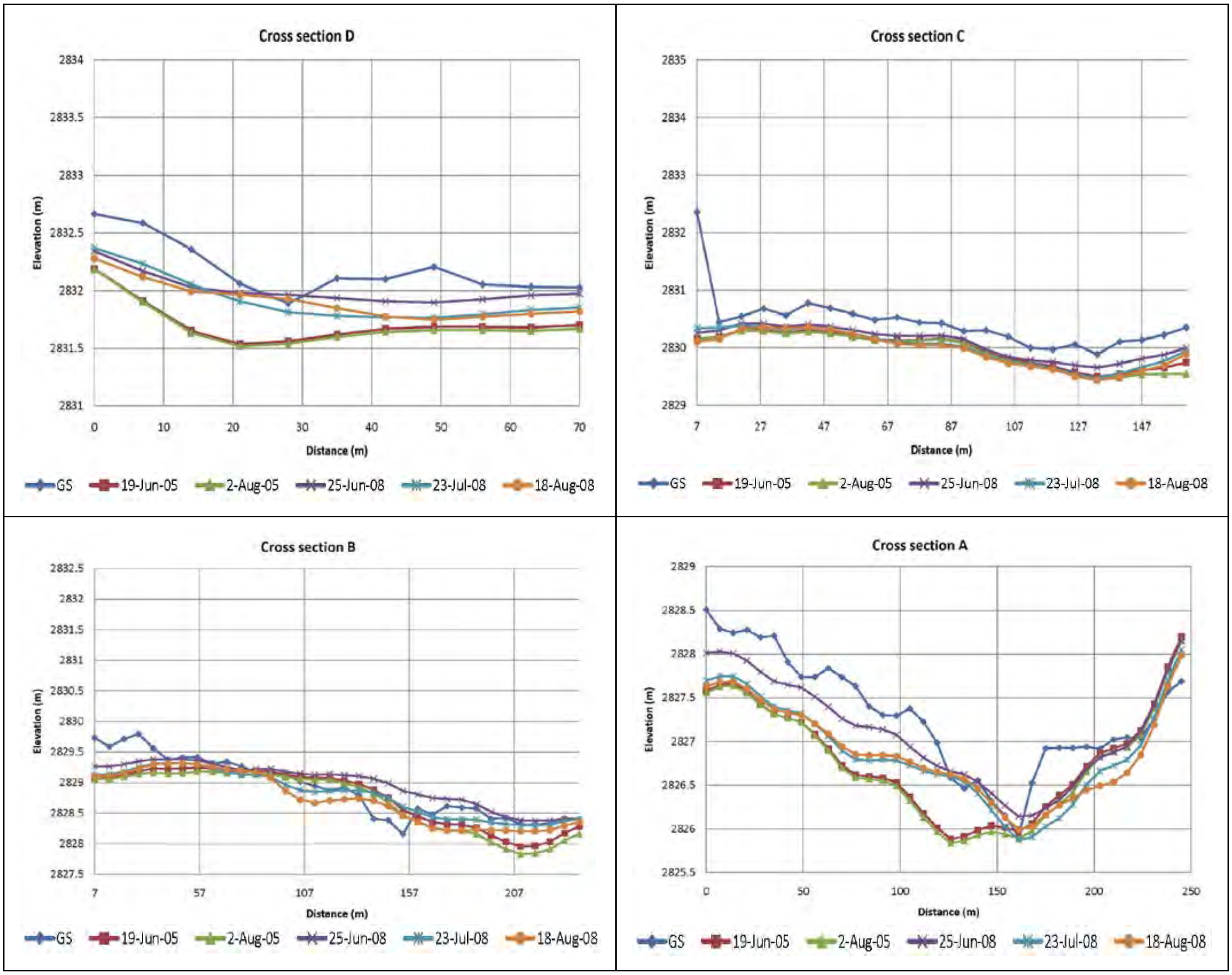


Figure 3.7b: Groundwater depths and profiles in the Lulu City wetland in 2005 and 2008. Section D is the Colorado River upstream of the wetland, and section A is about midway through the wetland. Ground surface is represented by the dark blue line.

Lulu Creek

Lulu Creek, which was affected by the Grand Ditch breach, flows south and east from its headwaters in the Never Summer Mountains to the Colorado River, approximately 5,700 horizontal feet downstream of the Grand Ditch diversion gate. Approximately 1,700 feet of this distance occurs downstream of the point where the 2003 debris deposits intersect the Lulu Creek channel. Lulu Creek is a high-gradient, perennial flowing stream, with a 2010 peak discharge of 125 cubic feet per second. Peak mean daily discharge was about 120 to 125 cubic feet per second (Rathburn 2011a). Average stream channel slope above the breach is about 5% (Rathburn 2007). Maximum daily flow in Lulu Creek was about 47 cubic feet per second in 2008 and 42 cubic feet per second in 2009 (Rathburn 2010). Discharge hydrographs show flow increasing from early April with the onset of snowmelt to a peak in late May, then dropping off in early June. During years when maximum water storage is achieved in Long Draw Reservoir and surplus water flows through Grand Ditch, water is allowed to bypass the Grand Ditch diversion gate and flow down Lulu Creek. The hydrograph indicates that Lulu Creek augments flow in the Colorado River by as much as 50% prior to and following the peak of the hydrograph (Rathburn 2007).

Hydrologic Effect of the Grand Ditch

Surface flows and the spring and summer hydrology of Lulu Creek, Sawmill Creek, and other headwater tributaries to the Colorado River are affected by the operation of the Grand Ditch. This water diversion project alongside the Never Summer Mountains predates the establishment of Rocky Mountain National Park. Construction was begun in 1890 and completed in 1937. The 17-mile system delivers an average of 20,000 acre-feet of water annually over the Continental Divide at La Poudre Pass, into Long Draw Reservoir, and then to the eastern plains of Colorado by diverting water from the Colorado River to the Cache la Poudre River. Between mid-May and mid-September of each year, the ditch captures the flow of 11 headwater tributaries of the Colorado River, intercepting an average of 29% of the total annual runoff from the Upper Colorado River watershed (Woods 2000). This reduces instantaneous annual peak flows of all recurrence by as much as 55%, the frequency of overbank flooding and channel maintenance flows by about 50%, the amount of surface water in the Colorado River watershed above Baker Gulch by about 50%, and the 3-, 7- and 30-day low flows by about 40% (Woods 2000).

In addition, water levels in the toeslope wetlands of Lost Creek have been reduced by as much as 20 inches, and in Red Creek more than 20 inches, below the surface in a year with low summer rainfall. Surface flows in both of these Colorado River tributaries are intercepted by the Grand Ditch. The impact of the Grand Ditch on river stage and groundwater levels in the Kawuneeche Valley is less noticeable, with approximately a 4- to 8-inch decrease due to the river's large width compared to its depth (Woods 2000). Colorado River channel locations and quantities of surface flows in the Lulu City wetland have changed many times since completion of the Grand Ditch, as the aerial photographs in figure 3.6 illustrate. Streamflows in this area that are perennially affected by Grand Ditch diversions also result in diminished ecological functions in streams (e.g., erratic overbank flooding and altered sediment transport dynamics).

STREAM CHANNEL MORPHOLOGY

Stream channel morphology is composed of the size, pattern, and shape of stream and river channels and their associated banks. Streams and rivers are dynamic (always changing) landforms subject to rapid change in channel shape and flow pattern. Water and sediment discharges determine the dimensions of a stream channel (width, depth, meander wavelength, and gradient). Dimensionless characteristics of stream channels and types of pattern (braided, meandering, straight) and sinuosity are significantly affected by changes in flow rate, sediment discharge, type of sediment load (ratio of suspended to bed load), and valley gradient. Dramatic changes in streambank erosion within a short time may indicate changes in sediment discharge, channel capacity, or water volume. Changes in alluvial channel cross-section, especially width, may indicate change in the discharge characteristics of the stream.

Streams are dynamic and can be in a balanced state or in a state of change (aggradation/degradation). A stream channel is in a balanced state when it is equal in aggradation (depositing material) and degradation (erosion of material). It is not necessarily stationary but can migrate vertically and laterally across its valley, eroding and depositing equal amounts of material, including streambank erosion. In unaltered, balanced systems, streams also overtop their banks. The floodplains store and slow floodwaters and allow streams to deposit sediment outside the channel. In contrast, unbalanced streams are in a state of change, resulting in excessive erosion of streambanks and deepening of channels or deposition and aggradation of the channel. These changes can happen laterally or vertically.

The rapid and temporary release of coarse sediment by the breach introduced massive quantities of material that clogged the channels and created an unbalanced condition in Lulu Creek and Colorado River channels. The accumulation of materials in the channels (aggradation) reduced channel capacity causing water to overflow the channel and spill onto the adjacent banks and floodplains. The overbank flooding can lead to the scouring of a new channel that bypasses the aggradated reach. The process of abruptly changing a channel's location in a floodplain or valley from one position to another is called avulsion.

Stream channel physical conditions (morphology) and water flow conditions (hydrology) interact to produce the current stream conditions. These existing conditions are summarized for the three primary watercourses in the project analysis area.

Lulu Creek

As a result of the debris and sediment flow, Lulu Creek has undergone substantial channel morphologic changes, including step-pool bedforms in a state of change, channel widening and increasing shallowness, channel splitting and braiding, channel incision, channelbank erosion and instability, alluvial fan expansion, and avulsion.

Upstream of the junction with the debris flow gully, Lulu Creek is a steep-gradient, step-pool channel, with steps created by width-spanning trees derived from local banks and of cobble- to boulder-sized rocks. Step-pools in the channel maximize streamflow resistance, which leads to maximum channel stability (Abrahams et al. 1995). The presence of steps and the associated step-pool complex is important for flow energy dissipation, especially during floods. Energy dissipation limits the erosive nature of floods on channel beds and streambanks. Step-pool spacing is about 15 feet in Lulu Creek upstream of the gully confluence, and stream width in the unaffected portion of the creek ranges from 8 to 16 feet (Rathburn 2012). Step-pools were present in Lulu Creek before the 2003 breach, as evidenced by the presence of these features in Lulu Creek upstream of the breach and in adjacent Sawmill Creek. Sawmill and Lulu Creeks serve as the ecological reference condition.

Downstream of the junction with the debris flow gully, Lulu Creek has been dramatically altered and is progressively changing to achieve a stable or balanced stream channel condition. Here, Lulu Creek is a wide expanse of coarse material that no longer displays the same step-pool morphology of upstream reaches. However, the stream has reformed step-pools at an average of 10 to 15 feet apart in some stretches since 2003. In some places along the impacted reaches of Lulu Creek, a 10-fold increase in width of the exposed alluvium has resulted because of the erosive nature of the debris flow (Rathburn 2007). Also, deposits of eroded debris and sediment along the length of Lulu Creek have formed thick, easily eroded banks that degrade during spring snowmelt periods or intense thunderstorms.

Figure 3.8 illustrates current conditions of the Lulu Creek channel upstream of the confluence with the erosion gully formed by the ditch breach and channel conditions downstream of the gully confluence in 2003 and in 2011. These pictures also show areas where channel avulsions have resulted from both the 2003 breach and the reworking of 2003 materials during 2011 peak flows.

A debris fan formed at the confluence of Lulu Creek and the Colorado River as the channel gradient decreases at the wider valley junction, decreasing sediment transport capabilities and depositing a fan of boulder- through sand-sized sediment and abundant tree trunks. The fan is cut by stream incision, and thus both Lulu Creek and the Colorado River can erode the exposed and unstable debris material and transport it downstream.

Downstream from the Lulu Creek confluence, the morphology of the Colorado River channel has changed in response to the debris mobilization and transport. Substantial sediment deposition and channel changes occurred during exceptional snowmelt runoff periods that resulted in high flows in

2010 and 2011. Measurements from the U.S. Geological Survey's Baker Gulch gaging station documented that June 2010 (975 cubic feet per second) and July 2011 (provisional measurements indicated the peak was approximately 2,000 cubic feet per second) flows were two of the three highest peak river discharges since recordkeeping began in 1953. The original 2003 breach and subsequent high flows that caused debris mobilization and transport have led to various avulsion events along with the list of morphological changes previously described. For further discussion of impacts on Lulu Creek (Zone 2), please reference the "Purpose and Need" and "Project Background" sections.

Colorado River

The Colorado River channel through the project area shows varying channel morphology from a single-thread, pool-riffle form, with pools on the insides of meander bends, to a braided and multi-thread form where the channel gradient becomes less steep and sediment is deposited. The Colorado River channel was transformed by the large sediment load to dissected and braided channels in several locations. The 2003 event deposited debris in topographic low areas, such as pools and wetlands, changing the channel characteristics to accommodate the increased sediment. This is an example of channel avulsion. In the middle and lower portions of the Lulu City wetland, deposition of sediment was predominantly sand-sized particles.

Excess sediment caused channel aggradation in many locations (Rathburn 2007). Higher than usual sediment movement will continue to occur as suspended and bedload sediment is mobilized during high-flow events. Suspended and bedload sediment will be transported downstream toward the Lulu City wetland, where some of it will be retained. Some sediment will continue to move through the wetland, down the Colorado River channel, and out of the project area. This process was observed in 2011 when higher-than-normal 2011 snowmelt runoff eroded and transported large amounts of sediment downstream into the lower part of zone 2 and into zones 3 and 4, which changed the shape and location of the river channel in several locations (figure 3.9). The figure shows Colorado River stream, channel, and floodplain conditions as they existed in August 2011 after the runoff period was finished. Sediment deposits appear as white materials. For further discussion of impacts on the Colorado River (zone 3), please reference the "Purpose and Need" and the "Project Background" sections.

Lulu City Wetland

The cumulative effects of historical and 2003 debris flows, and the associated reworked sediment deposition from high flow years, have created a braided channel system in the Lulu City wetland. Figure 3.10 presents the range of channel conditions. Unvegetated sediment deposits have accumulated in the north end of the wetland as a sediment fan has forced the river to flow into numerous shallow braided channels to the east and west sides of the wetland. The number, sizes, directions, and physical characteristics of these channels change annually in response to flow velocities and durations. As the multiple channels flow south through the wetland, they narrow and deepen or broaden and become shallower, based on wetland topography. All of the channels and flow collect into a single river channel at the south end of the wetland. In dispersing channel flow through numerous braids and surface routes, the wetland historically has provided and continues to provide important sediment retention and flow attenuation functions. Headcuts are present in several locations in the wetland where high velocity flows scoured out new channels from more readily erodible sediments. For further discussion of impacts on the Lulu City wetland (zone 4), please reference the "Purpose and Need" and the "Project Background" sections.

Upstream view of unaffected Lulu Creek upstream of gully in zone 1B in 2011 (August)

Upstream view of Lulu Creek downstream of gully in zone 1B in 2003 with footbridge in background

Upstream view of Lulu Creek downstream of zone 1B in 2011 (August) with footbridge in background

Downstream view of Lulu Creek channelbank of unstable debris and sediment in 2011 (August)

Figure 3.8: Stream channel morphology conditions of Lulu Creek

Upstream view of new deposits formed by 2011 snowmelt discharge on Colorado River downstream of Lulu Creek confluence (August 2011)

Upstream view of Colorado River channel upstream of confluence with Lulu Creek in 2011 showing stable channelbanks (August 2011)

Upstream view of Colorado River channel upstream of the Lulu City wetland showing transported sediment deposits on the floodplain in August 2011

Downstream view of Colorado River channel at the confluence with the Lulu City wetland (background) and debris and sediment deposits (August 2011)

Figure 3.9: Colorado River channel morphology at selected locations upstream of the Lulu City wetland

Downstream view of sediment and debris deposition at head of the Lulu City wetland guiding Colorado River channel and flow to west side of wetland (August 2011)

Downstream view of Colorado River channel on east side of the Lulu City wetland following historical central route; channelbanks vegetated (August 2011)

Downstream view of Colorado River flow following shallow swale through sedges and into central wetland area toward the east side (August 2011)

Downstream view of Colorado River meander and eroding sediments deposited in central wetland area during 2011 snowmelt runoff (August 2011)

Figure 3.10: Colorado River morphology in the Lulu City wetland

WATER QUALITY

The proposed restoration area is high in the headwaters of the Colorado River drainage. The river source begins in a wetland complex, about 2 miles upstream of the confluence of Lulu Creek and the Colorado River.

Water quality in the proposed action area is regulated by the Colorado Water Quality Control Division through established stream standards that were most recently amended in July 12, 2010 (Colorado Department of Public Health and Environment 2010b). The designated uses for stream segment 1, which includes the river mainstem, all of its tributaries, and wetlands inside the park are:

- Cold water aquatic life, class 1
- Recreation class E (existing primary contact use)
- Water supply
- Agriculture

Stream segment 1 is designated an "Outstanding Waters (OW)", which means it meets criteria for high water quality, occurs in a wilderness area, and possesses ecological significance (Colorado Department of Public Health and Environment 2010b). This designation means that water quality "shall be maintained at its existing quality" because it constitutes an outstanding natural resource. Existing quality is defined as the conditions that existed in 2000. Outstanding Waters are protected under the antidegradation rule, which allows no degradation of Outstanding Waters by regulated activities is allowed. This provision applies to tributary wetlands, which includes the Lulu City wetland and other wetlands along the Colorado River.

The segment of the Colorado River mainstem, all its tributaries, and wetlands downstream of the park boundary to Arapahoe National Recreation Area is designated stream segment 2. This segment is an undesignated segment, meaning it is a reviewable water. Stream segment 2 is not designated an Outstanding Water. The water quality standards applicable to this segment are the narrative basic standards for a reviewable water as defined in section 31.11 (Colorado Department of Public Health and Environment 2010a). These standards establish basic water quality conditions necessary to support propagation of fish, shellfish, and wildlife and to support recreation in and on the water. For all surface waters, except wetlands, there are six water quality conditions established to keep surface waters free from point and non-point sources of pollution and contaminants (section 31.11 (1)(a)). For surface waters in wetlands, there are two conditions established to protect these waters from toxic substances and conditions that affect pH, beneficial uses, and other water characteristics from both point and non-point sources of pollution (section 31.11(1)(b)).

The quality of these waters may be altered so long as applicable use-based water quality classification and standards are met. An example use classification applicable to the project area is aquatic life cold water – class 1. Table 3.3 compares the characteristics of the two segments.

Table 3.3: Comparison of Colorado River Water Quality Segments in the Project Area

Stream Segment Name	Segment	Designation	Use Classifications
Colorado River within Rocky Mountain National Park	1	Outstanding Water	Aquatic life, coldwater, class 1 Recreation E Water supply Agriculture
Colorado River within Arapahoe National Recreation Area	2	Reviewable Water (Undesignated)	Aquatic life, coldwater, class 1 Recreation E Water supply Agriculture

This use classification from Regulation 31.13 State Use Classifications includes waters that (1) currently are capable of sustaining a wide variety of cold water biota, including sensitive species or (2) could sustain such biota but for correctable water quality conditions. These waters are considered capable of sustaining such biota where physical habitat, water flows or levels, and water quality conditions result in no substantial impairment of the abundance and diversity of species (Colorado Water Quality Control Division 2010).

Colorado has water quality standards for wetlands, which are implemented by the Water Quality Control Division. Water quality regulations (5 Colorado Regulations 1002-31.5) define wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." This is the definition applied by the Corps of Engineers for Clean Water Act Section 404 jurisdiction. For the regulations, Colorado provides additional definitions for "constructed" wetlands, "created" wetlands, and "tributary" wetlands.

The Lulu City wetland and other wetlands hydrologically linked to the Colorado River upstream of the Lulu City wetland are tributary wetlands. Tributary wetlands are the headwaters of surface waters or wetlands within the floodplain that are hydrologically connected to surface waters by either surface or groundwater flows. The hydrologic connection may be intermittent or seasonal but must be of sufficient extent and duration to normally reoccur annually. Tributary wetlands do not include constructed or created wetlands (Colorado Department of Public Health and Environment 2010a). Tributary wetlands are subject to the same water quality classifications as the surface water to which they are most directly connected.

The Colorado water quality antidegradation policy is applied to all waters of the state and provides that except where authorized by permits, best management practices, 401 certifications, or plans of operation approved by the Water Quality Control Division or other applicable agencies, state surface waters shall be free from substances attributable to human-caused point source or non-point source discharge in amounts, concentrations, or combinations in wetlands that produce color, odor, changes in pH, or other conditions in such a degree as to create a nuisance or harm water-quality-dependent functions or impart any undesirable taste to significant edible aquatic species of the wetland; or are toxic to humans, animals, plants, or aquatic life of the wetland (Colorado Department of Public Health and Environment 2010a; Kusler 2011).

The stream classification and numeric standards for water quality parameters for stream segments 1 and 2 are presented in appendix G.

Most water quality sampling information available for the park comes from sampling 122 pond and lake sites (Mast 2007) and from a park baseline water quality information compilation and analysis (NPS 2001b). However, the project area encompasses only four of Mast's stream sampling sites and six NPS sampling stations. The nearest U.S. Geological Survey gaging and monitoring site is Baker Gulch, which is inside the park on the Colorado River about 7.8 miles straight-line distance (about 13.3 river miles) downstream of the Lulu City wetland boundary. Although it has been operating since 1953, it provides only limited water quality data for the river (376 samples as of 2011), mostly based on samples collected from 1995 to 1998 (USGS 2011).

Table 3.4 compares water quality parameter concentrations from six samples collected from Sawmill Creek, Lulu Creek, and Lady Creek where the Grand Ditch crosses each stream above the breach site to the larger data set available for the same parameters from the Colorado River at Baker Gulch and from a few points on the Colorado upstream of Baker Gulch. Sawmill Creek, a tributary of the Colorado River, is the first drainage south of and parallel to Lulu Creek. Sawmill Creek joins the river about 900 feet downstream of the Lulu Creek confluence. Lady Creek is the first drainage north of and parallel to Lulu Creek, which drains into the river about 3,000 feet north of the Lulu Creek confluence with the river. The parameter concentrations are very similar for these locations. None of the parameters exceed their respective water quality standard.

Table 3.4 also provides existing information on water quality parameters that could be affected by future wetland and channel restoration activities in the project area. The parameter concentrations are very similar for these locations; however, the effect of the Grand Ditch on the hydrology of these creeks may alter certain parameter concentrations. Though there is no existing water quality data for surface water or groundwater in the Lulu City wetland, none of the parameters reported in table 3.4 exceed applicable standards. These parameters include suspended sediment, turbidity, dissolved solids, organic carbon, and nutrients (especially ammonia, nitrate, and phosphates). None of these parameters has numeric water quality criteria or standards, but all values are relatively low at this downstream Colorado River location.

Based on water quality analyses reported by Spahr et al. (2000) and the U.S. Geological Survey (2011) for the Baker Gulch station, concentrations of ions were fairly dilute, and sediment and nutrient (nitrogen and phosphorus) concentrations were low. Water quality relationships to streamflow indicated that as the streamflow increased, the concentration of the major ions was diluted. The water at this site typically is a calcium-bicarbonate type (calcium and bicarbonate are the dominant ions). Suspended sediment concentrations were low (median of 2 milligrams per liter [mg/L]). The major ions (represented by total dissolved solids) followed a typical dilution type response (with the possible exception of phosphates), which shows ion concentrations decreasing with increased streamflow. This pattern occurs because base-flow concentrations are diluted by snowmelt runoff water. Suspended-sediment and dissolved organic-carbon concentrations increased with increasing streamflow, which resulted from the increased capacity of greater streamflows to transport material from source areas within the watershed. Dissolved iron concentrations reflect geologic sources of iron and the reducing environment of the large wetland areas in the basin. Nitrite plus nitrate concentrations were low (typically less than 0.15 mg/L) and showed no general relation to streamflow. Most total phosphorus concentrations were less than the laboratory minimum reporting level.

While within water quality standard limits, pH data from Baker Gulch indicate that mean and median pH from measurements taken in 2010–2011 (based on a total of seven samples) is 7.8, where the mean and median for measurements taken from 1995–1998 (based on a total of 64 samples) is 7.3. This pH increase may be related to periphyton growth in the river, which uses available carbon in the form of bicarbonate, thus reducing alkalinity and the buffering capacity of the stream. In such a system, pH varies on a diurnal cycle, peaking in the afternoon— a phenomenon often missed by discrete sampling events. Periphyton growth is generally a function of water temperature, sunlight, nutrients, and discharge. A U.S. Geological Survey periphyton sample collected in 2009 in the Colorado River below Baker Gulch indicates that at 155 milligrams per square meter, chlorophyll-a would exceed the State of Colorado's proposed nutrient standard of 150 milligrams per square meter. Because this finding is based on limited data at one location in the watershed 13.3 river-miles downstream from the breach-impacted site, detailed monitoring will be implemented to establish both a baseline of information and a time-series dataset robust enough to determine biological significance.

Water quality in the river is considered excellent, as indicated by its Outstanding Waters designation by the Colorado Water Quality Control Commission and historical water quality sampling programs in the park (Mast 2007). Water quality in this segment and the restoration area is not directly influenced by discharges from municipal, industrial, or agricultural sources. The primary water quality parameters of concern associated with the breach and the subsequent transformations of the streams affected by the breach are total nitrogen, nitrates, total phosphorus, dissolved organic matter, turbidity, suspended sediments, and trace metals (Clow and Mast 2004).

Within the reaches of the Colorado River, Lulu Creek, and the Lulu City wetland proposed for restoration, water quality conditions change naturally and seasonally in response to spring snowmelt and runoff, summer thunderstorms, and vegetation senescence in the late fall and early winter. In the Lulu Creek section downstream of the breach, sediment transport is substantially different and greater than before the breach occurred. Large quantities of unstable mineral materials from the channel bed and from adjacent bank deposits of transported sediment are eroded and transported downstream primarily during snowmelt runoff. These suspended sediments increase water turbidity during the runoff period. Before the breach, temporary seasonal increased turbidity conditions most likely occurred but at a much lower level because bank and channel conditions were protected from water erosion by vegetation, boulders, logs, and exposed bedrock. Although the Lulu City wetland can intercept and retain some of the transported sediments, some of the smaller-sized sediments and turbidity pass through the wetland and continue downstream out of the project area. During high-runoff years, such as 2010 and 2011, more sediment would pass through the wetland than would occur during more typical runoff years.

Similar water quality conditions for turbidity and suspended sediments did and currently do occur in the Colorado River below the confluence with Lulu Creek. This condition persists into the upper area of the Lulu City wetland, where reductions in water velocity caused the deposition of suspended sediments and reduction of water turbidity. The Lulu City wetland has other measurable effects on water quality.

Potential natural sources of water contaminants include erosion from seasonal flooding and geologic weathering. Potential anthropogenic sources of contamination in the project area include atmospheric deposition, water supply diversions, and recreational use (NPS 2001b). Potential anthropogenic sources of contaminants are limited to sources that occur downstream of the restoration area and outside the park boundary. These sources include municipal and industrial wastewater discharges, stormwater runoff, agricultural activities, and recreational use (NPS 2001b).

Table 3.4: Summary of Existing Surface Water Quality Information for Project Area and Baker Gulch Station (U.S. Geological Survey Station 09010500)

Water Quality Parameter	Location / Station Name / Mean Concentration (minimum – maximum values)[a]										
	Sawmill Creek[b]	Sawmill Creek[b]	Lulu Creek[b]	Lulu Creek[b]	Lulu Creek[c]	Lady Creek[b]	Colorado River above Lulu Creek[d]	Colorado River below Lulu Creek[d]	Colorado River below Project Area[d]	Colorado River at Baker Gulch[e]	Water Quality Standard[f]
	605	606	608	609	616	612	--	--	--	09010500	
Specific conductance	73 (NA)	105 (NA)	47 (NA)	129 (NA)	53 (NA)	20 (NA)	-	-	-	68 (37–127)	-
pH (standard units, su, field)	8.0 (NA)	5.6 (NA)	7.6 (NA)	5.4 (NA)	7.6 (NA)	5.9 (NA)	7.47 (7.33–7.57)	7.19 (5.68–7.51)	7.69 (7.57–7.75)	7.4 (6.8–8.2)	6.5 to 9.0
Alkalinity (mg/L)	580 (NA)	-	370 (NA)	-	427 (NA)	-	-	-	-	23 (12–31)	-
Phosphate, soluble (mg/L)	0.004 (NA)	-	0.003 (NA)	-	0.004 (NA)	-	-	-	-	0.037 (0.003–0.061)	-
Calcium, diss. (mg/L)	7.4 (NA)	-	4.3 (NA)	-	5.2 (NA)	-	-	-	-	7.5 (4.2–10.0)	-
Magnesium, diss. (mg/L)	-	-	1.2 (NA)	-	1.6 (NA)	-	-	-	-	1.8 (1.0–2.5)	-
Sodium, diss. (mg/L)	0.85 (NA)	-	1.8 (NA)	-	-	-	-	-	-	1.6 (0.9–2.2)	-
Potassium, diss. (mg/L)	0.26 (NA)	-	0.41 (NA)	-	0.34 (NA)	-	-	-	-	0.84 (0.50–3.50)	-
Chloride, diss. (mg/L)	0.4 (NA)	-	0.4 (NA)	-	0.3 (NA)	-	-	-	-	0.2 (0.1–0.8)	250 for water supply
Sulfate, diss. (mg/L)	7.4 (NA)	-	4.2 (NA)	-	4.9 (NA)	-	-	-	-	5.2 (2.7–7.4)	250 for water supply
Silica, diss. (mg/L)	7.5 (NA)	-	16.6 (NA)	-	12.3 (NA)	-	-	-	-	7.4 (4.8–9.7)	-
Nitrogen, ammonia (mg/L)	0.0	-	0.0	-	0.0	-	<0.007 (NA)	<0.007 (NA)	<0.007 (NA)	0.038 (<0.002–0.06)	pH and temperature dependent
Nitrate, nitrogen (mg/L)	0.09 (NA)	-	0.09 (NA)	-	0.2 (NA)	-	0.08 (0.05–0.12)	0.12 (<0.01–0.12)	0.10 (0.08–0.13)	0.09 (0.05–0.14)	10 for water supply
Uranium (diss.) (µg/L)	-	3.76 (NA)		2.92 (NA)	-	1.24 (NA)	-	-	-	<1.00 (<1.00–<1.00)	-

Table 3.4: Summary of Existing Surface Water Quality Information for Project Area and Baker Gulch Station (U.S. Geological Survey Station 09010500) (Continued)

Water Quality Parameter	Location / Station Name / Mean Concentration (minimum – maximum values)[a]										Water Quality Standard[f]
	Sawmill Creek[b]	Sawmill Creek[b]	Lulu Creek[b]	Lulu Creek[b]	Lulu Creek[c]	Lady Creek[b]	Colorado River above Lulu Creek[d]	Colorado River below Lulu Creek[d]	Colorado River below Project Area[d]	Colorado River at Baker Gulch[e]	
	605	606	608	609	616	612	--	--	--	09010500	
Suspended sediment (mg/L)	-	-	-	-	-	-	2.3 (0.4–5.9)	1.6 (0.0–5.2)	2.3 (1.5–3.2)	11.5 (0–217)	-
Turbidity (NTUs)	-	-	-	-	-	-	-	-	-	<2 (NA)	-
Dissolved solids (mg/L)	-	-	-	-	-	-	-	-	-	45 (23–51)	-
Dissolved solids (tons/AF)	-	-	-	-	-	-	-	-	-	0.06 (0.04–0.09)	-
Organic carbon, diss. (mg/L)	-	-	-	-	-	-	-	-	-	2.4 (1.0–5.5)	-
Chlorophyll a, (mg/m^2)	-	-	-	-	-	-	-	-	-	60 (1–155)	
Pheophytin a, (mg/m^2)	-	-	-	-	-	-	-	-	-	62.1[g] (NA)	

a. Values in parenthesis are minimum and maximum concentrations. NA means not applicable because only a single value was reported.
b. Station at Grand Ditch crossing; one sample measurement (NPS 2001b).
c. Station upstream of Grand Ditch crossing; one sample measurement (NPS 2001b).
d. Clow and Mast (2004); nine samples collected between April and October 2004.
e. Colorado River at Baker Gulch station; values are means based on multiple sample measurements (USGS 2011).
f. Colorado Department of Public Health and Environment (2010b).
g USGS collection at Baker Gulch station; one sample collected on 9/16/10.

WETLANDS

INTRODUCTION

The National Park Service has a responsibility under Executive Order 11990 (Protection of Wetlands) to protect wetlands. Executive Order 11990 directs the National Park Service to (1) provide leadership and to take action to minimize the destruction, loss, or degradation of wetlands; (2) preserve and enhance the natural and beneficial values of wetlands; and (3) avoid direct or indirect support of new construction in wetlands unless there are no practicable alternatives to such construction and the proposed action includes all practicable measures to minimize harm to wetlands.

Director's Order #77-1 (NPS 2002c) and Procedural Manual #77-1 (NPS 2011k) established a "no net loss of wetlands" policy for the NPS. Any wetland degradation or loss associated with proposed NPS actions must be compensated for by replacing lost wetland acreage and functions elsewhere in the park. Wetland restoration activities on disturbed wetland sites are not typically considered to be new adverse impacts, and so may be excepted from this compensation requirement. Director's Order #77-1 (2002c) also adopted the Cowardin et al. (1979) wetland classification system as the NPS standard for defining, classifying, and inventorying wetlands.

In addition to the requirements of the Director's Order, NPS activities that involve the discharge of dredged or fill material into wetlands or other "waters of the United States" must also comply with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. The Corps of Engineers and the U.S. Environmental Protection Agency are jointly responsible for administering the provisions of Section 404 and Section 10. Wetlands are defined differently under the Cowardin et al. (1979) system and the Clean Water Act / Rivers and Harbors Act regulations. Both approaches for defining wetlands are discussed below.

Wetland resources described in this affected environment section follow the Cowardin system. The National Park Service will determine the location, quantities, and types of effects on wetlands and waters of the U.S. that are subject to Section 404 jurisdiction by conducting formal wetland delineations as the restoration designs move into later, more detailed phases of development.

Under the Cowardin wetland definition (used by the NPS) and the Clean Water Act wetland definition (used by the Corps of Engineers), three parameters are used to identify and map wetlands: wetland hydrology, hydrophytic (wetland) vegetation, and hydric soil. The *Corps of Engineers Wetlands Delineation Manual* (USACE 1987) requires that all three of the parameters be present for an area to be considered a wetland (with some exceptions). The Cowardin wetland definition includes such wetlands but also adds some areas that, though lacking vegetation and/or soils due to natural physical or chemical factors such as wave action or high salinity, are still saturated or shallow inundated environments that support aquatic life (e.g., unvegetated stream shallows, mudflats, rocky shores). This is important because NPS wetland protection policies and procedures apply to this broader range of wetlands, and compliance with the NPS no-net-loss-of-wetlands policy requires that all wetlands (as defined by the National Park Service) are considered in the analysis. Most of these additional shallow aquatic environments, as well as most deepwater habitats, are still regulated as waters of the United States under the 404 permit program.

A wetland is defined by the Cowardin system as

> Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil;

> and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

A wetland is defined in Section 404 of the Clean Water Act as

> Those areas that are inundated or saturated by surface or groundwater (hydrology) at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation (hydrophytes) typically adapted for life in saturated soil conditions (hydric soils). Wetlands generally include swamps, marshes, bogs, and similar areas (40 CFR 232.2(r)).

Wetlands that exhibit all three characteristics (wetlands hydrology, hydrophytic vegetation, and hydric soils, as described above) are termed "jurisdictional wetlands" and are regulated by the U.S. Army Corps of Engineers under Section 404. Wetlands are a subset of "waters of the United States" and thus subject to Section 404. The term "waters of the United States" has broad meaning and incorporates both deep-water aquatic habitats and special aquatic sites, including wetlands (USACE 1987).

The evaluation of environmental effects on wetlands in this environmental impact statement addresses those defined by the Cowardin system.

WETLAND FUNCTIONS

Wetlands provide valuable ecological functions, including but not limited to the following (Kent 1994): terrestrial and aquatic wildlife habitat, floodflow attenuation and control, sediment retention, groundwater recharge and discharge, water quality, and primary biomass production.

The existing Lulu City wetland (zone 4) is a large wetland (about 43 acres), and its functions are commensurate with its size. For example, larger wetlands tend to have more diversity, often support larger populations of component species, are more likely to support sparsely distributed species, and may provide a wider variety of wildlife habitat as well as more ecological services derived from natural ecological processes (e.g., sediment/nutrient retention, floodwater storage, biomass production) than smaller wetlands (Rocchio 2005).

Field observations indicate that all of these wetland functions are being provided by the Lulu City wetland and the unnamed wetlands that flank the Colorado River in zone 3. Evidence of elk and moose browsing of stunted willow plants, waterfowl and muskrat use of former beaver ponds, and trout in the rivers and meanders indicate fish and wildlife habitat functions. The retention and attenuation of spring snowmelt flows with a concurrent decrease of sediment loads are evidence of floodflow and sediment retention and water quality improvement functions provided by the wetlands. These functions are probably less effective in the Lulu City wetland than before the 2003 breach. The discharge of groundwater from the toe of adjacent sideslopes and the infiltration of surface waters into wetland soils indicate that the groundwater discharge and recharge functions operate in the wetlands. The dense wetland canopy cover of sedges, willows, and hydric grasses is evidence of primary biomass production, although this function may be performing less effectively than before the 2003 breach because some vegetated areas in the wetland were buried by sediment.

Elk and moose consumption of willow biomass keeps the willows stunted. This effect is very apparent by comparing willow size and density in the Lulu City wetland to willow stands that are protected from elk, deer, and moose browsing by fenced enclosures at three sites in the Kawuneeche Valley inside the park (Shepherd 2008). Willows inside the enclosures are 8 to 12 feet tall, while unfenced willows in Lulu City wetland are 1 to 3 feet tall and show extensive evidence of browsed stems through the entire wetland. Stunted willows and extensive evidence of elk and moose browsing are also apparent in the Shipler Park wetland reference area.

WETLAND ACREAGE AND LOCATION

Wetland acreage estimates and locations are based on National Wetland Inventory maps (USFWS 2011a) that show Cowardin system wetlands and on later field investigations that were conducted in 2012 (Cooper and Schook 2012). Additional, more detailed wetland delineation and inventory work would be completed as part of later restoration design activities. The field delineation activities conducted in 2012 (Cooper and Schook 2012) addressed both the Cowardin system and jurisdictional wetlands defined for purposes of complying with Section 404 of the Clean Water Act. Table 3.5 provides a summary of the wetland types and quantities in each restoration zone.

Table 3.5: Summary of Cowardin system and jurisdictional wetland types and areas

Zone	Area (acre)	Cowardin Wetland Type
1	0.15	Riverine, upper perennial, rock bottom, rubble[a]
1	0.25	Palustrine, forested[b]
Zone 1 total acres of wetland 0.40		
2	0.42	Riverine, upper perennial, rock bottom, rubble[a]
2	0.51	Palustrine, forested[b]
Zone 2 total acres of wetland 0.93		
3	1.15	Riverine, upper perennial, rock bottom, rubble[a]
3	4.04	Palustrine, emergent[b]
3	4.93	Palustrine, scrub-shrub[b]
Zone 3 total acres of wetland 10.12		
4	0.53	Palustrine, scrub-shrub[b]
4	0.78	Riverine, upper perennial, unconsolidated bottom[a]
4	26.33	Palustrine, emergent[b]
Zone 4 total acres of wetland 27.64		
Total	**39.09**	

Source: Cooper and Schook (2012)
Note: The wetland inventory of zone 4 only includes the area of project activity.
a. Cowardin wetland but not jurisdictional wetland
b. Cowardin and jurisdictional wetland

Wetlands were present in zones 3 and 4 before the Grand Ditch breach and still exist, although their size, the wetland species density, and wetland functions changed as a result of the 2003 debris flow. Based on the partial wetland inventory of 2012, there were approximately 39.1 acres of Cowardin system wetlands and jurisdictional wetlands present in the restoration zones. Figure 3.11 shows the approximate bounds of the existing wetlands in all zones based on the 2012 delineation.

The wetlands in zones 3 and 4 are in the Colorado River valley bottom. Their water supply is primarily provided by seasonal snowmelt and relatively shallow groundwater inflows; it is augmented by summer thunderstorms. Groundwater levels are generally highest in the spring, with surface soils in the wetlands saturated during the peak of snowmelt and for some time after, usually through May and into June. Groundwater levels recede through late summer and the end of the growing season. Surface water flow through zone 4 varies as channels shift with seasonal redistribution of deposited sediments during spring runoff. The Colorado River, once flowing primarily through the center of the Lulu City wetland, now branches into several channels as it passes through the wetland. A substantial amount of surface flow passes along the west side of the wetland as a result of the sediment deposits. Refer to the hydrology section of the environmental impact statement for more detail regarding groundwater and hydrological support for wetlands.

The primary wetland types in zones 3 and 4 are classified as palustrine, shrub-scrub; palustrine, emergent; riverine, upper perennial, unconsolidated bottom; and riverine, upper perennial, rock bottom, rubble according to the Cowardin system (USFWS 2011a).

The portion of the Lulu City wetland east of the historical Colorado River channel contains fen wetlands that were not subject to the 2003 breach sediment deposition that occurred in the northern and western portions of zone 4. A small fen, located along the west side of zone 4, was buried by sediment deposits from the 2003 breach (Cooper 2011). Fen wetlands are peat-forming wetlands that receive nutrients from sources other than precipitation, usually from upslope sources through drainage from surrounding mineral soils and from groundwater movement. The hydrological support for the zone 4 fens is provided by groundwater seeps from the mountain slopes east and west of zone 4. Fens differ from bogs because they are less acidic and have higher nutrient levels. They therefore can support a much more diverse plant and animal community (USEPA 2011). Fens take centuries to form, and their losses are essentially irreparable. Therefore, the U.S. Fish and Wildlife Service has elevated fens to a the most protected "Resource Category 1," and the U.S. Army Corps of Engineers has exempted fens from the Nationwide 26 permit coverage that would allow adverse fill effects (USEPA 2011).

DOMINANT WETLAND SPECIES

The dominant wetland species found in the zone 3 and 4 wetlands (based on approximate total percent canopy cover) include planeleaf, mountain, and Drummond willow (*Salix planifolia*, *S. monticola*, *S. drummondiana*), water and beaked sedge (*Carex aquatilis* and *C. utriculata*), and bluejoint grass (*Calamagrostis canadensis*). These species are considered hydrophytic (meeting the regulatory definition for a wetland plant species) and are on the *National List of Vascular Plant Species that Occur in Wetlands: 1996 National Summary* (USFWS 1997). Refer to the "Vegetation" section for more information about plant species in the project area, including exotic, non-native species.

SOIL CHARACTERISTICS

The parent soils in zones 3 and 4 are in the soil unit Kawuneeche mucky peat on 0% to 4% slopes. This soil unit formed on floodplains is poorly drained, floods frequently, and the average depth to groundwater is 12 inches (USDA, Natural Resources Conservation Service 2011a). Kawuneeche mucky peat is on the list of hydric soils.

Soil conditions in the wetland are a heterogeneous mix because of the depositional nature of this site. Sediment deposited by the 2003 event accumulated on top of peat, recent organic soils, and sediment deposits that collected in the wetland before the 2003 breach. During particularly high spring runoff as in 2010 and 2011, surface sediment deposits are reworked and redistributed in the wetland. Because of these processes, the wetland soil is a blend of old and new and of organic and mineral materials. This blending is apparent both horizontally and vertically within the wetland. The blend of organic and mineral components in the soils forms a variety of soils across the wetlands, which in turn affects soil water permeability, infiltration rates, and groundwater characteristics. This mix of soil types can support diverse wetland plant communities, ranging from hydrophytic grasses (e.g., bluejoint) and sedges to several willow species.

Historical sediment flows, as well as the sediment from the 2003 breach, have buried large areas of peat and organic soils in zones 3 and 4. At least 9.5 acres of wetland in the northern and western portions of zone 4 (Cooper 2006) and an estimated total of 15.7 acres of wetlands in all zones were buried or scoured away by the 2003 debris flows. This estimate accounts for wetland, stream channel, and riparian areas that were buried between Lulu Creek and the north end of the Lulu City wetland. Since that field assessment in 2003 and 2004 (as reported in 2006), spring runoff has imported additional sediment from upstream deposits into the wetland. Field observations revealed spring flows also reworked and transported existing sediment in the wetland further downgradient within the Lulu City wetland, thereby expanding the size of the sediment deposition impact. In many locations, the dominant wetland willow, sedge, and grass species have survived and sprouted through the sediment deposits from the 2003 breach and previous sediment deposition events.

Refer to the geology section of this environmental impact statement for more information about soils.

POTENTIAL FOR RECOVERY OF WETLAND COMMUNITY

The dominant wetland species found in zones 3 and 4 can be categorized as relatively rapid growing, easy to establish, species. Disturbed mineral soils, such as those that would result following removal of sediment or making changes in channel alignments, would provide excellent growing media for the willow species that would be used to restore the wetland community (Brown and Smith 2000). In addition, water and beaked sedges are fast-growing, pioneer species that can become established where the water table is within 8 to 10 inches of the surface during the growing season. Both species are also tolerant of prolonged shallow standing water (usually 1 to 6 inches above the surface). The hydrological support provided by snowmelt and summer precipitation would provide high potential for restoration of the wetland community because of the abundant water supply, rapid growth, aggressive rooting capabilities, and colonizing nature of the dominant wetland species. A key requirement for establishing the desired ecological reference condition is establishing the appropriate depth to groundwater and surface water conditions required for successful establishment and sustainability of the target willow and sedge species.

Planting willow and sedge species within their appropriate hydrologic regimes is critical to restoration success. Therefore, careful consideration will be needed during preparation of the detailed design to make sure that the proper water table zones are created during restoration. If the correct species are planted in the correct hydrologic zones, establishment success should be high.

There are several example reference locations. One is a large, relatively undisturbed willow, sedge, and hydric grass wetland in Shipler Park, along the Colorado River about 1 mile downstream from the Lulu City wetland. Shipler Park's proximity; the similarity of aspect, elevation, habitat, soils, and hydrological regime to zones 3 and 4; and its plant community composition and distribution all contribute to its high value as a reference wetland.

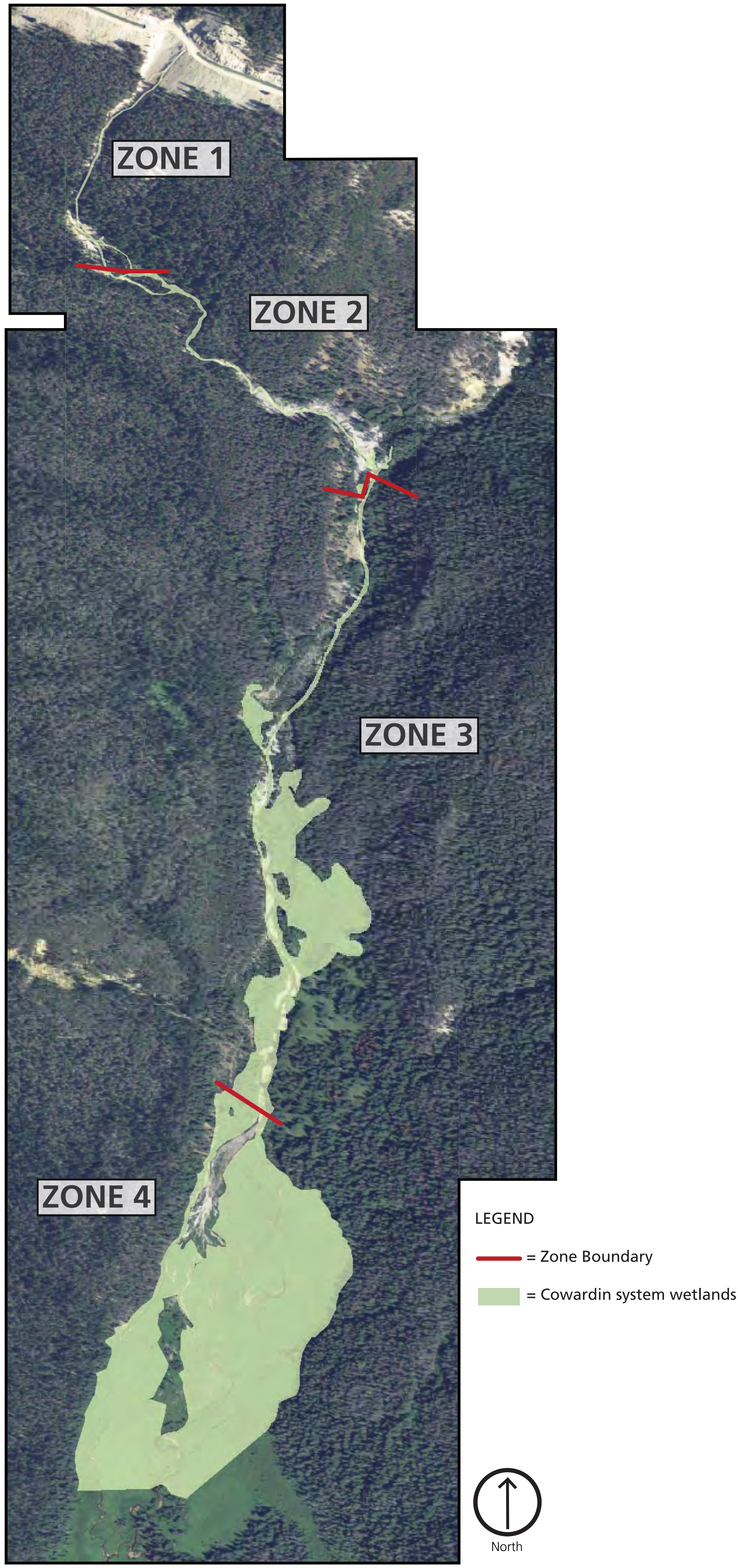


Figure 3.11: Bounds of Cowardin system wetlands

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VEGETATION

INTRODUCTION

This description of vegetation resources is organized into three broad habitat categories: upland, riparian, and wetland. These categories represent the habitats that support vegetation in and surrounding the area affected by the May 2003 Grand Ditch breach. As described in chapter 1, "Project Background," the area of impact is divided into four zones representing different geo-ecological areas (figure 1.5). The dominant vegetation in each of these zones is described for the three habitat categories. Rather than present an exhaustive list of the species that were present prior to the breach and those currently present, only the dominant species are described. The dominant species are the focus because the proposed action, if implemented, would attempt to create conditions supporting reestablishment of the dominant species and subsequent restoration of the species composition and community functions that existed before the breach. A more detailed list of plant species likely to be found in the area affected by the breach can be found in appendix H (Cordova 2006).

Rocky Mountain National Park lies within the Dry Domain, Temperate Steppe Division and Southern Rocky Mountain Steppe – Open woodland – Coniferous Forest – Alpine Meadow Province. This ecoregion is characterized by dramatic vertical zonation of vegetation, a consequence of abrupt elevation gradients between flatlands and mountains. Topographic relief is quite dramatic, and in a short distance, one may see various life zones (NPS 2006b). Due to the variation in elevation, climate, and soils, Rocky Mountain National Park contains nine distinct vegetation types, ranging from grass/shrub meadows at 7,800 feet to alpine tundra above 11,500 feet in elevation. Approximately 60% of the park is forested, 13% is above tree line, 18% consists of exposed rock, and 9% is a mixture of other habitat types (NPS 2005a).

The area affected by the breach lies within the subalpine life zone between the elevations of approximately 9,300 and 10,200 feet above mean sea level (Beidleman et al. 2000). The primary ecosystems affected are subalpine forest and wet meadow, with a discontinuous riparian corridor that becomes more robust with decreasing elevation and the less steep gradients found in zones 3 and 4.

The dominant vegetation associations throughout the area of effect are the subalpine fir / grouse whortleberry forest (*Abies lasiocarpa* / *Vaccinium scoparium* forest association) and the sedge / willow wetlands (*Carex* spp. / *Salix* spp. wetland association). Although establishment of exotic, nonnative species is currently low, the disturbed soils provide conditions well suited for exotic plants. The establishment of invasive nonnative species in the areas disturbed by the breach is minimal, with scattered dandelion (*Taraxacum officinale*), Canada thistle (*Cirsium arvense*), timothy (*Phleum pratense*), and yellow salsify (*Tragopogon dubius*) (Shorrock 2010).

UPLAND VEGETATION

Upland ecosystem functions include, but are not limited to, wildlife habitat, soil stabilization, erosion and water release control, nutrient cycling, ground shading, air purification, and carbon sequestration (Cordova 2006). Upland vegetation is found in each of the four zones although it strongly predominates in zones 1 and 2. Flora and fauna species diversity is relatively low in the upland forests (Vankat 1979), especially compared to the riparian and wetland areas.

The upland forest in all zones is currently subject to a mountain pine beetle infestation (figure 3.12). The mountain pine beetle (*Dendroctonus ponderosae*) is native to the forests of western North America.

Periodic outbreaks of the insect, such as the current one, can result in losses of millions of trees. Mountain pine beetles develop in pines, particularly ponderosa, lodgepole, Scotch, and limber pine. Lodgepole pine is the species most affected in the project area. During early stages of an outbreak, attacks are limited largely to trees under stress from injury, poor site conditions, fire damage, overcrowding, root disease or old age. However, as beetle populations increase, mountain pine beetle attacks may involve most large trees in the outbreak area (Leatherman et al. 2007). The current outbreak appears to have peaked in the project vicinity about 2008; however, the extent of beetle-killed trees is quite substantial.

Figure 3.12: Beetle-killed trees near Granby, Colorado

Zone 1 Upland

The dominant woody upland species in zone 1 would include lodgepole pine, subalpine fir, and Engelmann spruce. The habitat conditions that favor these species vary widely, with lodgepole pine showing the greatest variability and adaptability. The fir and spruce prefer cooler, moister locations than lodgepole pine (Brown and Smith 2000).

The understory in zone 1 was dominated by grouse whortleberry. Whortleberry would have accounted for almost half the ground cover in the upland reaches of zone 1, with litter and bare ground/rock composing the remainder. A few other species, including creeping barberry (*Mahonia repens*), and common juniper (*Juniperus communis*) would have been scattered through the understory (Cordova 2006). These species grow well in the understory at the elevations and water regime found in reference uplands for zone 1.

Cordova (2006) estimated that over 2,100 trees were destroyed or lost in the 2.28 acres of zone 1 directly affected by the breach. Virtually all vegetation, including over- and understories, was eliminated by the debris flow generated by the breach. This loss correlated with the complete loss of ecological services in zone 1 (Cordova 2006; Peacock 2007).

Zone 2 Upland

The vegetative community within this area is characterized as a spruce/fir forest and subalpine riparian area. Of the 8.48 acres within the zone, the upland forest covered 6.07 acres. The upland portion of zone 2 was severely injured by the debris flow, with a 25% to 50% loss of mostly understory vegetation. Conservative estimates indicate that natural recovery of previous understory plant communities would take 75 to 100 years (Cordova 2006).

The dominant vegetation in the upland portion of zone 2 does not differ markedly from what would have been found in zone 1. The dominant upland canopy species in zone 2 are lodgepole pine, Engelmann spruce, and subalpine fir, with grouse whortleberry the dominant understory species (Cooper 2006).

Shorrock (2010) reported the establishment of hundreds of fir and spruce seedlings in and around a sample plot within the disturbed area of zone 2, as well as an herbaceous understory dominated by grouse whortleberry.

Zone 3 Upland

Zone 3 is primarily defined as the 6.66-acre riparian zone and the 0.73-acre Colorado River channel (Cordova 2006). As a result, there is no upland plant community to consider formally within the bounds of zone 3. Nonetheless, there are upland communities adjacent to the zone on both sides, and the dominant upland species are the same as the upland portion of zone 2; Engelmann spruce, subalpine fir, and grouse whortleberry.

An assessment of upland vegetation conditions in the zone 3 area disturbed by the breach showed that many of the tree seedlings that were found growing in 2003 (Cordova 2006) had died (Shorrock 2010).

Zone 4 Upland

Zone 4, like zone 3, is not defined to include an upland plant community. The zone is composed mostly of the Lulu City wetland, with a riparian component along its borders. Also like zone 3, the upland plant community surrounding zone 4 consists of a spruce/fir forest dominated by a grouse whortleberry understory.

RIPARIAN VEGETATION

Mountain riparian ecosystems form long, sinuous, discontinuous bands of varying width adjacent to streams, rivers, and other water bodies (Mutel and Emerick 1992). The functions provided in the riparian zone functions are distinct from the upland ecosystem. These ecological functions include bank and soil stabilization; sediment containment; erosion resistance; flood control; microclimate control; wildlife cover, forage, and nesting habitat; and shade for aquatic habitats (USFS 2002). In some of the zones below the Grand Ditch, the species composition in the riparian areas is not substantially different from the uplands because the forest species grow right to the edge of the channels. However, the species do transition from an upland role to riparian ecological role. For example, subalpine fir trees growing in the valley bottoms along Lulu Creek and the Colorado River provide additional functions common to riparian species such as streambank stabilization, shading of aquatic habitat, and attenuation of floodflows.

Zone 1 Riparian

There was no drainage channel in the reaches of zone 1 prior to the breach; thus, no riparian vegetation was present.

Zone 2 Riparian

This reach supported a 2.41-acre riparian forest on the Lulu Creek valley floor mixed with upland forest on slopes. The riparian vegetation on the Lulu Creek floodplain was a mature Engelmann spruce and subalpine fir forest with a high density of herbaceous and shrub plant species. The location in the valley bottom and relatively shallow groundwater make water availability high, resulting in very tall trees with very large diameters (Cooper 2006).

The vegetation in the zone 2 riparian corridor was likely dominated by Engelmann spruce, subalpine fir, lodgepole pine, plane-leaf willow, mountain willow, Drummond willow, and several understory species, including arrowleaf ragwort (*Senecio triangularis*), tall fringed bluebells (*Mertensia ciliata*), prickly currant (*Ribes lacustre*), and heartleaf arnica (*Arnica cordifolia*). The species composition is based on observations made by Cooper (2007c) on the portion of Lulu Creek upstream of the area affected by the breach.

Zone 3 Riparian

Zone 3 includes the Colorado River from its confluence with Lulu Creek downstream to the Lulu City wetland. The vegetation in this zone is largely upper montane riparian plant species common to the upper Colorado River drainage, particularly tall willows. Zone 3 covers 7.39 acres, including a 0.73-acre stream channel and the riparian ecosystem that covers 6.66 acres (Cooper 2006).

The Colorado River from its confluence with Lulu Creek downstream through the Lulu City wetland was heavily impacted by the Grand Ditch breach. Riparian vegetation in the zone 3 riparian corridor was dominated by stands of willows, with bluejoint (*Calamagrostis canadensis*), other grasses, and various herbaceous dicots in the understory. Beaked sedge (*Carex utriculata*) is a dominant species in the riparian corridor in the bottoms of oxbows and in abandoned river channels. Portions of the zone 3 riparian zone that are slightly elevated above the banks of the river support scattered growth of Engelmann spruce, subalpine fir, and lodgepole pine (Cooper 2007c). Thinleaf alder (*Alnus incana*) and narrowleaf cottonwood (*Populus angustifolia*) likely grew in gaps in the coniferous canopy and in places where the river was wide enough to allow abundant light (Rocchio 2005). Quaking aspen (*Populus tremuloides*) are notably absent in zone 3, but it may be a candidate species for restoration along the riparian corridor, given the proper aspect, sun exposure, and availability of water.

Zone 4 Riparian

The 1.7-acre riparian area along the Colorado River was deeply buried by sediment deposited by the breach debris flow. Dozens of trees were killed, including willows, and the river channel was filled with sediment. Little recolonization by willows can occur under current conditions due to the high groundwater levels in some areas of zone 4 throughout the growing season and the dry sandy condition of the sediment burying the channel and riparian zone. The sediment created sand bars throughout the central part of the Lulu City wetland and likely killed many plants (Cooper 2006).

The dominant species in the riparian corridor of zone 4 include plane-leaf, mountain, and Drummond willows, water sedge, beaked sedge, and bluejoint (Cooper 2006). Lodgepole pine are present along the periphery of zone 4 and have become established on sediment deposits in scattered locations across the zone.

WETLAND VEGETATION

Wetland ecosystems provide numerous important ecological functions. The “Wetlands” section discusses the ecological functions of wetlands. Wetlands are found in zone 3, while zone 4 is almost entirely wetland. These wetlands are classified as palustrine, shrub-scrub, and seasonally flooded (PSSC), according to the Cowardin classification system (USFWS 2011a).

Zones 1 and 2 Wetland

Wetland vegetation is assumed not to be present in zones 1 and 2. Wetland vegetation, growing in jurisdictional wetlands, may have been present in very small, scattered pockets (on the order of several square feet) along the edges of the stream channel, although the breach has removed evidence of wetland presence. The small size and discrete locations combine to minimize the value of the wetland functions these small pockets of wetland vegetation would provide. The steep gradient and fast flows in zones 1 and 2 eliminate the potential for wetland formation.

Zones 3 and 4 Wetland

Before the Grand Ditch breach, the Lulu City wetland area was primarily a stand of willows and sedges covering 43 acres. Sediment deposits buried a minimum of 9.5 acres of wetland and stream ecosystems in the Lulu City wetland complex (Cooper 2006), burying and killing 90% to 100% of the willows and sedges. The total estimate increases to about 15.7 acres after accounting for wetland, stream channel, and riparian areas that were buried between Lulu Creek and the north end of the Lulu City wetland. Since that field assessment was completed in 2003 and 2004 (as reported in 2006), spring runoff events have imported additional sediment from upstream deposits into the wetland. Field observations revealed that spring flows also reworked and transported existing sediment in the wetland further downgradient, thereby expanding the size of the wetland impact.

The center portion of the wetland was once dominated by plane-leaf, mountain, and Drummond willows; water and beaked sedges; and wetland grass (bluejoint). The species composition is known from what is present under the sediment and plants that have sprouted through the sediment from remnants of buried plants. However, the sediment-covered portion of zone 4 has poor recovery potential because the sediment has lowered the water table by raising the ground surface. The density of willows, sedges, and other wetland plants that could be supported under current conditions is much lower than before the breach. Some areas, such as the beaver ponds that were in zone 4 before the breach, are filled with sediment so deep that emergent and submergent vegetation can no longer be supported and are unrecoverable in their current condition. Before the breach, the Lulu City wetland had a primary channel lined with willows. Currently, the sheetflow hydrologic regime over the sediment deposits primarily supports a water sedge community, and the sedge appears to be increasing in dominance (Shorrock 2010).

Although no exotic plant species were detected in 2004 surveys, there are now scattered Canada thistle invasions on some of the disturbed soils in zone 4. There is a high likelihood that additional thistle or other nonnative plant species could invade bare surfaces in the future (Cooper 2006). A vegetation assessment performed in 2010 stated, “Numbers of exotics remained low and with the exception of Canada thistle, which is moderately to highly invasive, the taxa were naturalized or slightly to moderately invasive” (Shorrock 2010).

The Lulu City wetland vegetation is now dominated by the short-stature plane-leaf willow that survives in the sheetflow conditions of the wetland. If the channel was restored to its historical location through the middle of the wetland, rather than along the western side, and the surface water–groundwater interactions were restored to pre-breach conditions, the wetland could support mountain and Drummond willows. Residual, declining stands of mountain and Drummond willow provide evidence of historically much larger stands of these willows in and on the periphery of the breach impacted area and at the reference sites (McLaughlin 2011). The reasons for their decline likely include altered hydrological conditions, increased browsing pressures, declining beaver populations, and the presence of pathogens. These dominant wetland species would provide the desired vegetation to support beaver and trout populations and to stabilize streambanks (Cooper 2007b). However, field observations and aerial photograph reviews of reference wetlands such as Shipler Park do not indicate the presence of large, dense stands of tall willow (i.e., mountain or Drummond willow). This may indicate that plane-leaf willow, a shorter-stature plant than mountain or Drummond willow, is the dominant willow in the wetlands. Plane-leaf willow has been shown to tolerate wetter conditions and reduced soil conditions better than mountain willow (Cottrell 1996).

The portion of the zone 4 wetland east of the historical Colorado River channel contains fen wetlands that were not subject to the sediment deposition that occurred in the northern and western portions of the wetland. Refer to the wetland section of this environmental impact statement for more details concerning fen wetlands.

ECOLOGICAL REQUIREMENTS

Some of the dominant species growing throughout zones 1 through 4 have a wide range of ecological requirements. Habitat elements such as lifespan, groundwater depth, shade tolerance, and soil preference are important for maximizing the chances of restoration success. Table 3.6 presents the upland, riparian, and wetland dominant species and summarizes their important ecological requirements and preferences. Sources of information are cited in table footnotes.

Table 3.6: Ecological Requirements and Preferences of Dominant Species

Common Name	Scientific Name	Lifespan (years)	Shade Tolerance	Water Regime	Soil Preference	Comments
Engelmann spruce[(a)]	*Picea engelmannii*	250–450, up to 600 or more	Tolerant	At equal basal area, annual canopy transpiration is about 80% greater than lodgepole pine and 50% greater than subalpine fir. Its high rates of transpiration cause Engelmann spruce to occur primarily on moist sites.	Grows best on moderately deep, well drained, loamy sands and silts and silt and on clay loam soils developed from a variety parent rock. Good growth also on glacial and alluvial soils developed from a wide range of parent materials, where an accessible water table is more important than physical properties of the soil.	Slow growing, shallow root system, susceptible to windthrow and spruce beetle. The ability to survive is favored by adequate soil moisture, cool temperature, and shade.
Subalpine fir[(a)]	*Abies bifolia*	150–200, seldom exceeds 250	Favors shade	At equal basal area, annual canopy transpiration is about 35% lower than spruce but 15% higher than lodgepole pine. These high rates of transpiration cause subalpine fir to occur primarily on wet sites, generally in association with Engelmann spruce.	Soil materials vary according to the character of the bedrock where they originated. Glacial deposits and stream alluvial fans are also common along valley bottoms. Subalpine fir is not exacting in its soil requirements; it frequently grows on soils that are too wet or too dry for its common associates.	Slow growing, susceptible to western spruce budworm.
Lodgepole pine[(a)]	*Pinus contorta*	150–200 average, up to 300 or more	Very intolerant	Intermediate in water need, requiring more than Douglas fir and ponderosa pine and less than Engelmann spruce and subalpine fir Does not tolerate saturated soil for long.	Growth is best where soil parent materials are granites, shales, and coarse-grained lavas.	Serotinus cones found on some lodgepole pine require fire to release seed; very susceptible to mountain pine beetle.

Table 3.6: Ecological Requirements and Preferences of Dominant Species (Continued)

Common Name	Scientific Name	Lifespan (years)	Shade Tolerance	Water Regime	Soil Preference	Comments
Grouse whortleberry[(b)]	*Vaccinium scoparium*	Long-lived; lifespan linked to fire regime	Very tolerant	Withstands heavy snowpack, although early season snowmelt is common. In many areas, the potential for drought exists by midsummer.	Grows on dry to moist, well drained, rocky, sandy, and gravelly loams; requires acidic soils and thrives where pH ranges from 4.3 to 5.2.	Valuable food source for many birds and small mammals; very sensitive to trampling.
Narrowleaf cottonwood[(b)]	*Populus angustifolia*	100–200	Very intolerant	Flood disturbance along waterways enhances seedling recruitment.	Colonizes sandbars and other fresh alluvium.	Useful for soil stabilization in erosion control and streambank reclamation projects.
Plane-leaf willow[(b)]	*Salix planifolia*	50–65 years	Intolerant	Forms thickets along stream margins, in wet meadows and seep areas, and on slopes kept moist by melting snow. Sites are usually wet, with water tables at or near the surface, although greater depths in late summer are tolerated.	Soils may be mineral or organic. Mineral soils are clayey-, silty-, or sandy-textured and overlain by a shallow, organic surface layer.	Dominates low-statured shrub communities in high-elevation, wet mountain meadows; excellent wildlife cover habitat.
Mountain willow[(b)]	*Salix monticola*	50–65 years	Intolerant	Water table at 1.5 to 2 feet below ground surface in late summer. Growth severely reduced when water levels are maintained at or above the root collar for extended periods.	Grows on recent alluvial deposits characterized by exposed mineral soil. Mountain willow is usually found on moist sandy or gravelly soils but is adaptable to a wide variety of soils.	Important food and cover resource for wildlife.

Table 3.6: Ecological Requirements and Preferences of Dominant Species (Continued)

Common Name	Scientific Name	Lifespan (years)	Shade Tolerance	Water Regime	Soil Preference	Comments
Drummond willow[(b)]	*Salix drummondiana*	50–65 years		Preferred groundwater depth varies from near the surface to about 39 inches; maintained by seasonal flooding or high water tables.	Grows on moist, well-aerated mineral soils. Textures vary greatly, from cobbles and gravels to sandy or clay loams in broad valleys. Often occurs on fine-textured soils of sediment-filled beaver ponds.	Provides good cover for a variety of wildlife species. Recommended for use in revegetating disturbed riparian areas; especially useful for bank stabilization.
Thinleaf alder[(b)]	*Alnus incana*	40	Partially tolerant	Has a high flood tolerance and typically grows near rivers and moist stream borders on poorly developed soil.	Grows best in heavy, moist soils in light-shaded areas.	Pioneer species for revegetating disturbed riparian areas; a nitrogen fixator.
Water sedge[(b)]	*Carex aquatilis*	Perennial	Intolerant	Water table at 0.5 to 1 foot below ground surface in late summer.	Grows best in cold, moist soils with textures ranging from sandy loam to clay; associated with soils high in organic matter.	High nutritional value for wildlife.
Beaked sedge[(b)]	*Carex utriculata*	Perennial	Intolerant	Saturated soil, often in standing water.	Occurs on a range of soil types, with textures from silt loams or silty clays to loamy sands. Organic matter content commonly reaches 20%.	Common in willow and shrub fens. Low presence in treed fen areas but makes up 5% to 25% of cover in herbaceous fen areas.
Bluejoint[(b)]	*Calamagrostis canadensis*	Perennial	Intolerant	Moist to saturated, but not inundated.	Organic, high nutrient content.	Forage for deer, elk, and waterfowl.

a. Burns and Honkala 1990
b. Brown and Smith 2000

SPECIAL STATUS SPECIES

INTRODUCTION

The Endangered Species Act of 1973 requires evaluation of the effects of proposed actions on all federally listed endangered and threatened species and designated critical habitat with potential to be affected by the action. Species proposed for listing and candidate species also are evaluated. The U.S. Fish and Wildlife Service determines if a species needs protection under the Endangered Species Act and whether to classify a species as an endangered, threatened, proposed for listing, or candidate species. Endangered species are considered to be in danger of extinction throughout all or a significant portion of their range; threatened species are those likely to become endangered in the foreseeable future; species proposed for listing are in the process of being listed; and candidate species are determined to warrant protection and are being considered for listing as an endangered or threatened species. Candidate species do not have legal protection.

NPS policy also requires examination of impacts on federally listed, proposed, and candidate species and designated critical habitat as well as state-listed threatened, endangered, candidate, rare, declining, and sensitive species (NPS 2006a, section 4.4.2.3). The Colorado Division of Parks and Wildlife determines if a species needs legal protection within Colorado. Species listed as endangered or threatened by the state are defined in the same way as federal endangered and threatened species. The state also designates species of special concern, which have no legal protection.

Appendix B provides the biological assessment and Endangered Species Act, section 7 compliance for the federally listed species and designated critical habitats. Appendix I presents species in Rocky Mountain National Park listed by the U.S. Fish and Wildlife Service as federally endangered, threatened, or candidates for listing status as of April 7, 2011. The list of species considered endangered, threatened, or of special concern by the Colorado Division of Parks and Wildlife is included in appendix J. This list also includes rare species that occur in Rocky Mountain National Park. Table 3.7 includes federal and state-listed species known to occur in the park that may be affected by the restoration alternatives. These species have been retained for a full evaluation of effects. None of the special status species that may be affected by the Grand Ditch breach restoration project have designated critical habitat in Rocky Mountain National Park.

SPECIES RETAINED FOR FURTHER ANALYSIS

Table 3.7: Special Status Species with Potential to Be Affected

Common Name	Scientific Name	Status
Boreal toad	*Bufo boreas boreas*	SE
Wood frog	*Rana sylvatica*	SSC
Colorado River cutthroat trout	*Oncorhynchus clarki pleuriticus*	SSC
River otter	*Lutra canadensis*	ST
Canada lynx	*Lynx canadensis*	FT, SE
Wolverine	*Gulo gulo luscus*	FT, SE

Key to Status: FE = federally endangered; FT = federally threatened; FC = federal candidate for listing; SE = state endangered; ST = state threatened; SSC = state species of special concern

Boreal Toad

Southern Rocky Mountain populations of the boreal toad were a federal candidate for listing, but as of September 29, 2005, the U.S. Fish and Wildlife Service published a notice in the Federal Register notifying the public that they were no longer considering the toad for listing "because it does not constitute a distinct population segment as defined by the ESA" (USFWS 2005). The state of Colorado lists the toad as endangered because of large population declines from 1975 to 1990, and the species is retained in this EIS for further analysis. The Colorado Division of Parks and Wildlife developed a recovery plan in 1994, which was updated in 1997, 1998, and 2001 (Loeffler 2001). Rocky Mountain National Park is a signatory of the *Conservation Plan and Agreement for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad (Bufo boreas boreas)* (Loeffler 2001).

Boreal toads are the only high-elevation species of toad in Colorado, occurring from 7,000 to 12,000 feet. Breeding habitat includes lakes, marshes, ponds, bogs, and wet meadows with sunny exposures and quiet, shallow water. Breeding has been recorded from large permanent lakes, glacial kettle ponds, manmade ponds, beaver ponds, marshes, and roadside ditches (Loeffler 2001). Boreal toad breeding does not begin until the winter snowpack starts to thaw, which ranges from May to July in toad sites in Rocky Mountain National Park (Hammerson 1999). Young toads are restricted in distribution and movement by available moist habitat, while adults can move several miles and reside in marshes, wet meadows, or forested areas (Loeffler 2001). Severe population declines are attributed to a skin disease known as chytrid fungus (*Batrachochytrium dendrobatidis*).

By 1997, only the Kettle Tarn and Lost Lake, and possibly Spruce Lake, population sites in the Big Thompson River drainage supported significant breeding populations of *Bufo boreas* (Corn et al. 1997). By 2005, the chytrid fungus afflicting the toad populations had been implicated in the mass mortality events at both the Kettle Tarn and Lost Lake sites, resulting in precipitous population declines (Scherer et al. 2005).

A boreal toad survey of the Grand Ditch breach area conducted in the summer of 2009 found suitable habitat for the toad in the eastern portion of the Lulu City wetland, the only area of the breach footprint identified as suitable habitat. No toads were observed in the breach area during the 2009 survey; however, despite the lack of observations, there is a history of the boreal toad within the breach footprint (NPS 2009). In 1998, two toads were observed on the bank of the Colorado River near the Lulu City site, in the northern reaches of zone 4, just downstream from the confluence of the Colorado River and Little Dutch Creek. Additionally, in 2005, after the Grand Ditch breach, a female boreal toad was observed at a pond near Lulu City in zone 3, north of the Little Dutch Creek/Colorado River confluence. As a result of the 2009 survey and the previous sightings, it is known that the breach footprint and surrounding areas contain limited toad habitat. Additionally, the Lulu City area has historically been used by toads and may represent an important travel corridor for the species (NPS 2009).

There have been two boreal toad reintroduction sites in the Red Mountain Area of the Kawuneeche Valley. Both sites are approximately 165 by 330 feet; the nearest site to the project area is about 3 miles down the valley from the Lulu City wetland (NPS 2011f).

Wood Frog

The wood frog is a state species of special concern, downlisted from threatened in 1998 by the Colorado Wildlife Commission. It is of concern to the state because its distribution is small and disjunct (Hammerson 1999) and its habitat has suffered destruction and degradation.

Wood frogs are found in riparian areas, including beaver ponds and willow thickets. Wood frogs in Colorado inhabit subalpine marshes, bogs, pothole ponds, beaver ponds, lakes, stream borders, wet meadows, willow thickets, and forests bordering these mesic habitats. Their elevation range in Colorado is about 7,900 to 9,800 feet (Natural Diversity Information Source, no date). They feed on worms, spiders, and insects; their predators include trout, although they generally avoid areas inhabited by trout (Hammerson 1999).

In Rocky Mountain National Park, wood frogs have only been found in the Kawuneeche Valley (Corn et al. 1997). From 2004 to 2006, Scherer (2010) estimated the proportion of wetlands that were occupied by breeding wood frogs in the Kawuneeche Valley and found that breeding wood frogs occupied approximately 12% of the wetlands sampled. Contradicting prior beliefs that wood frogs tend to breed in the same wetlands across years, Scherer found relatively high levels of turnover in the wetlands used for breeding in the valley. Of the wetlands that were occupied by breeding wood frogs, approximately 33% were not occupied the following year.

At the scale of seasonal migration, occupancy by breeding wood frogs in the Kawuneeche Valley was positively related to the length of rivers and streams near a wetland. After breeding, wood frogs migrate to moist, cool areas and spend the drier portions of the year (summer and early fall) in these areas. Streamside locations may provide wood frogs with these conditions and, given the recent hydrologic alterations in the Kawuneeche Valley, may be one of the few reliable sources of this habitat in the valley (Scherer 2010).

Scherer's wood frog surveys did not detect any wetlands containing wood frogs within the Grand Ditch breach area, and most of the frog observations were clustered further south in the valley; however, there were some observations within approximately 2 miles of the Lulu City wetland. Alterations to landscapes that reduce or eliminate dispersal between local populations and between occupied and unoccupied wetlands may threaten the persistence of amphibian populations, and given the proximity of observed frogs to the project, the wood frog could be impacted by the project (Scherer 2010).

The breeding season of wood frogs is signaled when the males begin calling and may begin even before the last snowfall and while ice still forms on water at night. Depending on the year, this could be in May (Hammerson 1999), with eggs being laid in May to June (Bagdonis 1971).

Colorado River Cutthroat Trout

The Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) is a state species of special concern. Its decline is primarily due to competition and hybridization with nonnative fish, pollution, and habitat destruction (NPS 2007c). Due to extensive restoration efforts by the Colorado Division of Parks and Wildlife and U.S. Fish and Wildlife Service, this species has been removed from the state list of threatened species.

Colorado River cutthroat trout spawn after water flows have peaked in spring or early summer; spawning can begin as early as April and end as late as July, depending on elevation. The timing of spawning is closely associated with water temperature, and in local cutthroat streams, spawning begins when stream temperatures reach 5°C (41°F). An abundance of spawning gravels is also necessary for successful spawning. Typically, spawning gravels range in size from 0.4 to 1.2 inches. Females deposit eggs from 3.9 to 9.8 inches deep in the spawning gravels. The composition of the substrate, particularly the proportion of fine particles, has been linked to the survival from deposition to fry emergence. Local water velocity and depth are important for redd development, with velocities of 1.3 to 2 cubic feet per second and water depths of 4 to 30 inches being preferred (USFS 2009). Young fish emerge from redds after accumulation of 570 to 600 Celsius degree days. Generally less than 1.2 inches after emergence, the young cutthroat are weak swimmers, which confines them to small, shallow, sheltered

A **redd** is a hollow in a riverbed made by a trout or salmon to spawn in.

backwaters with near-zero water velocities (USFS 2009). Coleman and Fausch (2006) found that nearly all backwaters habitats for fry are confined to channel margins.

The Colorado River cutthroat trout is native to the Upper Colorado River Basin and is found throughout the basin. In Rocky Mountain National Park, Colorado River cutthroat trout occur primarily in the Colorado River, Timber Creek, Onahu Creek, North Inlet, Ptarmigan Creek, and Paradise Creek. The trout is known to occur near the headwaters of the Colorado River, approximately 2 miles upstream from Lulu Creek's intersection with the Colorado River (USFS 2009). Fish sampling of the Colorado River at the Lulu City fish trend site documented the presence of the Colorado River cutthroat trout in low numbers at this location and in the branches of the river that flow through the Lulu City wetland (Kennedy 2003, 2006, 2008, and 2010; Kennedy and Rosenlund 2011). Because there are Colorado River cutthroat trout in the segment of the river affected by the Grand Ditch breach, this genetic uncertainty would not preclude an analysis of the Colorado River cutthroat trout, and this species will be carried forward for analysis. Any alteration of riparian areas or water quality has the potential to impact the Colorado River cutthroat trout.

River Otter

The river otter is state listed as a threatened species, downlisted from endangered by the Colorado Division of Parks and Wildlife in 2003. Otter populations have diminished as a result of habitat alterations, human encroachment, trapping, water diversions, and degradation of water quality. The river otter was formerly extirpated from the park, but 43 otters were reintroduced to the park in the upper Colorado River between 1978 and 1984 (Armstrong 1987).

Otters live in riparian habitat, where aquatic animals like crayfish, frogs, fish, young muskrats, and young beavers are favored foods; fish are usually the otter's primary food item, but they will also vary their diet with insects and aquatic birds when available. Otters usually live in bank dens abandoned by beavers. They are active mostly at dawn and dusk (Colorado Division of Parks and Wildlife 2010c). The presence of shrubs and stream shading are important variables that contribute to otters' habitat selection in the park (Herreman and Ben-David 2001). River otters in Rocky Mountain National Park breed in spring, but implantation does not occur for at least 8 months. Young are born in March or April (Armstrong 1987).

Based on otter population surveys performed in 2001 (Herreman and Ben-David 2001), the otter population along the Colorado River in the park was estimated at 18 animals. In 2010, a biannual population survey of otters in Rocky Mountain National Park by Merav Ben-David and Rocky Mountain National Park surveyed the riverbank of the Colorado River for latrine sites and fecal deposition rates upstream and downstream of the Timber Creek Campground, which is south of Lulu City and the Grand Ditch breach area. The 2010 survey indicated a recovery of these activity indices along the Colorado River after nearly 10 years of decline in the same stretch of river. After a decade of population surveys, it appears that otter numbers along the Colorado River are ephemeral and inconsistent from year to year. When the latrine sites and fecal deposition rates of the park are compared to other known estimates of the minimum number alive for river populations elsewhere (Kenai Fjords National Park, Kodiak Island Archipelago, and Prince William Sound, Alaska, and Vancouver Island, British Columbia), the data do not suggest an abundance of otters in the park (Ben-David 2010).

Management activities that could affect riparian vegetation along the Colorado River or actions with potential to affect water quality could affect the river otter.

Canada Lynx

The Canada lynx, a federally listed threatened species and state-listed endangered species, was reintroduced into southwestern Colorado by the state starting in 1999 to establish a viable population. During that first winter, the division had 19 records of four radio-collared lynx moving north from their release site and spending some time in or near the park between October 8, 1999, and April 28, 2000. Subsequent documented occurrences of lynx in the park include two confirmed and one probable sighting in 2006 and a photograph of a lynx near the park in 2009 (NPS 2011f).

The park contains approximately 145,815 acres (55% of the park) of potential lynx habitat. Mature conifer forests are necessary for denning, and riparian areas are frequented during the summer. Lynx are a specialized carnivore: snowshoe hares (*Lepus americanus*) provide up to 97% of their diet (Koehler and Aubry 1994). In Colorado, lynx are known to have a more varied diet that includes squirrels, mice, and birds; however, as in northern latitudes, the hare is still the primary dietary staple (NPS 2011f). Although uncommon, carrion (including ungulates) can also make up a large portion of a lynx's diet when other prey sources are scarce (Brand et al. 1976).

Human presence can have a major impact on lynx survival and behavior. For example, roads can be a primary source of mortality for lynx (NPS 2007c), and human activities, particularly in the winter, can cause lynx to avoid prime habitats (Oliff et al. 1999). However, repeated and consistent human disturbance will not necessarily preclude lynx from using an area, as they may adapt behaviorally or physiologically (Bowles 1995). Because mature forests and riparian areas provide habitat for the lynx during the summer, any potential management activities affecting riparian areas and mature forests may affect the lynx.

Wolverine

The wolverine is a state-listed endangered species and was recently proposed as a threatened species for federal endangered species protection. A 12-month finding on a petition to list the North American wolverine as an endangered or threatened species under the Endangered Species Act of 1973 was announced in December 2010 (USFWS 2010). On February 4, 2013 the USFWS proposed to list the wolverine as threatened. The wolverine's presence in Rocky Mountain National Park had not been confirmed until 2009, when a wolverine was sighted within the park boundaries. The last reported location of the wolverine, in February 2011, was in the Never Summer Range along the northwestern boundary of the park (NPS 2011f). Scientists estimate that 250 to 300 wolverines currently inhabit the contiguous United States (USFWS 2010).

Wolverines do not appear to specialize in specific vegetation or geological habitats but instead select areas that are cold and receive enough winter precipitation to reliably maintain deep, persistent snow late into the warm season (USFWS 2010). The requirement of cold, snowy conditions means that in the southern portion of the species' range, including Rocky Mountain National Park, where ambient temperatures are warmest, wolverine distribution is restricted to high elevations. The wolverine population in Colorado likely exists as a metapopulation, a network of semi-isolated populations, each occupying a suitable patch of habitat in a landscape of otherwise unsuitable habitat. Female wolverines use natal (birthing) dens that are excavated in snow. Persistent, stable snow greater than 5 feet deep appears to be a requirement for natal denning. Natal dens consist of tunnels that contain well-used runways and bed sites and may naturally incorporate shrubs, rocks, and downed logs as part of their structure. Offspring are born from mid-February through March, and the dens are typically used through late April or early May (USFWS 2010).

A **metapopulation** consists of a group of spatially separated populations of the same species which interact at some level.

Wolverines are very susceptible to human activities and may abandon their den sites in response to such minor disturbances as cross-country skiers (NPS 2007c). Though it is unlikely that there are any den sites in the project area, any disturbance from restoration activities could impact foraging habitats of the wolverine. Wolverines are opportunistic feeders and consume a variety of foods, depending on availability. They primarily scavenge carrion but also prey on small animals and birds, and eat fruits, berries, and insects. Wolverines require a lot of space. The availability and distribution of food is likely the primary factor in determining wolverine movements and home range size (USFWS 2010). The project area may contain habitat for the wolverine, and any management activities that alter foraging habits could potentially affect the species.

SPECIES EXCLUDED FROM FURTHER ANALYSIS

All species presented in appendixes I and J were considered during the development of this document. The bonytail (*Gila elegans*), Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*) do not occur in the park but are federally listed downstream species in the Upper Colorado River basin. Regardless of any changes in water flow in the Colorado River resulting from the alternatives, downstream flows would not be altered enough to affect these species, and they are not analyzed further (USFWS 2011b). The greenback cutthroat trout (*Oncorhynchus clarki pleuriticus*) does occur within the park but is found primarily in the North Fork of the Big Thompson River, Roaring River, Fern Creek, Hidden Valley Creek, and the Wild Basin area, areas primarily on the east side of the park. The greenback cutthroat trout also occurs in the upper Cache la Poudre River but on the east side of La Poudre Pass, opposite the project area (USFS 2009). The greenback cutthroat historically occurred in the South Platte and Arkansas River drainages, not in the Colorado River drainage, and would therefore not be expected to occur in the project area.

The least tern (*Sterna antillarum*), pallid sturgeon (*Scaphirhynchus albus*), piping plover (*Charadrius melodus*), and whooping crane (*Grus americana*) also do not occur in the park because they are federally listed downstream species in the South Platte River basin. None of these federally listed species are expected to be impacted by the alternatives addressed in this document.

Greater sandhill cranes arrive in Colorado by May to breed, have young in June, and migrate in August (Andrew and Righter 1992). The only known occurrence for greater sandhill crane in the park is a single pair that has nested in the southern Kawuneeche Valley, downstream of the Holzworth Ranch. Since 1997 the pair has nested in a riparian willow/herbaceous area along a beaver pond. The pair is known to have nested in this location as recently as the summer of 2010 (USFS 2009; NPS 2011f). The cranes prefer the open portions of the Kawuneeche Valley and have not been observed in the vicinity of the Grand Ditch breach area (NPS 2011d); therefore, they are not retained for further analysis.

The Barrow's goldeneye (*Bucephala islandica*), ferruginous hawk (*Buteo regalis*), American white pelican (*Pelecanus erythrorhynchos*), and long-billed curlew (*Numenius americanus*), state-listed species of special concern, all migrate through the park. Because these species do not nest in the park and the habitat that they use while migrating is not expected to be impacted by the alternatives, these species will not be retained for further analysis (NPS 2007c).

The American peregrine falcon (*Falco peregrinus anatum*) is a state-listed species of special concern with known nesting areas within the park. None of these nesting areas fall within the proposed project area, and none would be impacted. Neither the food source or habitat of the peregrine falcon overlap with current or possible activities related to this project; therefore, the species will not be retained for analysis. The bald eagle (*Haliaeetus leucocephalus*) is a state-listed species of special concern that occurs in the park; however, they generally forage in the habitat around Shadow Mountain Lake and Lake Granby. Bald eagles are not known to nest in the park, and because they do not often occur near the project area, they are dismissed from further analysis (NPS 2007c).

The yellow-billed cuckoo (*Coccyzus americanus*) does not occur in the park except accidentally but is found at lower elevations in Grand County. The Mexican spotted owl (*Strix occidentalis lucida*) does not currently occur in the park, and potential suitable habitat in the park occurs primarily on the east side of the park. Therefore, neither the owl's prey base nor habitat overlap with current or possible activities related to this project. These federally listed species are not expected to be impacted by the alternatives addressed in this environmental impact statement and will not be retained for further analysis (NPS 2007c).

The Rocky Mountain capshell snail (*Acroloxus coloradensis*), a state-listed species of special concern, occurs at only one location in the park (NPS 2007c). This species will not be retained for further analysis because this location is not expected to be impacted by any of the restoration alternatives.

The action alternatives may result in the return of beavers and beaver ponds and could therefore lead to a potential Endangered Species Act water depletion concern because of evaporative losses. However, this would not be considered an Endangered Species Act issue because it would result in the return of natural conditions that likely existed before the Grand Ditch breach; therefore, these species will not be retained for analysis (NPS 2007c). Additionally, beaver activity has been shown to raise the water table and ease water table decline during dry summer months, which would help counteract any evaporative loss that may occur (Westbrook et al. 2006).

The Preble's meadow jumping mouse (*Zapus hudsonius preblei*) does not occur in the park but occurs at lower elevations in the state (NPS 2007c). None of the actions associated with the project are expected to affect the jumping mouse or its habitat.

The Colorado butterfly plant (*Gaura neomexicana spp. coloradensis*) is a federally listed threatened species. The biggest threats to the plant are nonselective herbicide spraying, agricultural activities, water development, competition from exotic plants, and loss of habitat to urban growth. The plant grows in riparian areas at elevations below 7,000 feet, below that of the Grand Ditch breach area (NPS 2007c), and management actions associated with this project would not affect the Colorado butterfly plant; thus it is not retained for further analysis.

Ute ladies'-tresses (*Spiranthes diluvialis*) is a federally listed threatened species. The major threats to the species are related to loss of habitat from agriculture and development. The plant grows in riparian areas at elevations below 7,000 feet, and management actions associated with this project would not affect Ute ladies'-tresses because the project is at higher elevations than 7,000 feet (NPS 2007c). This species will not be retained for further analysis.

WILDLIFE

INTRODUCTION

The project area is along the eastern slope of the Never Summer Range within the Kawuneeche Valley, which serves as the uppermost portion of the Colorado River watershed. The project area contains four major habitat components for wildlife: upland forest areas consisting primarily of lodgepole pine, Engelmann spruce, and subalpine fir; riparian habitats along the Colorado River corridor, Lulu Creek, and Sawmill Creek that consist of Engelmann spruce, subalpine fir, narrowleaf cottonwood, and willows (*Salix spp.*); the Lulu City wetland complex; and the aquatic habitats of the Colorado River and lower Lulu Creek.

Nearly 350 vertebrates are found in the Rocky Mountain National Park area, including 276 species of birds, 52 mammals, 11 fish, four amphibians, and one reptile. The distribution of species within the park varies by season, elevation, and varieties of habitats present. Species that are not threatened or endangered but that may be affected by proposed restoration activities are described in this section. A full list of the known wildlife in the park is available on the Internet at https://nrinfo.nps.gov.

In the Kawuneeche Valley, declines in the willow population can be a problem in some vegetative communities. Elk and moose foraging is considered a primary factor driving productivity decreases in willow communities in areas of the park. Ungulate herbivory can influence many aspects of plant structure, growth, and net primary productivity, which results in shorter willow patches and subsequent effects on insect, bird, beaver, and small-mammal diversity (Zeigenfuss et al. 2002). Also, in some situations, elk may not be a primary factor in willow decreases, but the browsing pressures from an increased elk population exacerbate willow decline (Peinetti et al. 2002). A rapid willow decline in the valley may be attributable in part to a fungus, the same species that has been causing an aspen decline. This fungus is exacerbated by late summer high temperatures and declines in water hydrology that cause willow stress (NPS 2011f).

TERRESTRIAL SPECIES

Ungulates

Elk. Since 1969, the Rocky Mountain National Park / Estes Valley elk population has more than tripled. Population estimates peaked between 1997 and 2001, with annual estimates ranging from about 2,800 to 3,500 animals. Since 2002, winter estimates in the park and Estes Valley outside the park have declined, ranging from about 1,700 to 2,200 animals (NPS 2007c).

The Rocky Mountain National Park/Estes Valley elk population migrates seasonally between high-elevation summer ranges and low-elevation winter-range where snow is less deep and forage more available in winter. The primary summer range includes subalpine and alpine areas within the park (Zeigenfuss et al. 2011). Those elk that winter in Moraine Park use the Colorado River valley on the west side of the park, particularly the Kawuneeche Valley, during the summer and other times of the year. The project area is in the Kawuneeche Valley, which is characterized by extensive wet meadow areas surrounded by lodgepole pine. Riparian shrubs include mountain willow, flat-leaved willow, and mountain birch. Numerous aspen stands also occur (NPS 2007c). The most common browse species consumed by elk are willow leaves and stems, antelope bitterbrush (*Purshia tridentata*) stems, and shrubby cinquefoil (*Potentilla fruticosa*) stems (Hobbs et al. 1981). Elk use summer range primarily during June, July, and August. In September, a portion of the elk herd typically begins to migrate to low-elevation winter-range in the Estes Valley on the east side of the park and adjacent areas outside the park, as well as areas further east. The remainder of the Kawuneeche Valley elk population migrates to lower elevation areas in Grand County, on the west side of the Continental Divide. Elk typically return to the summer range beginning in May (Zeigenfuss et al. 2011).

Moose. In 1978 and 1979, the Colorado Division of Parks and Wildlife transferred two groups of 12 moose (*Alces alces*) from the Uintah Mountains and Grand Teton herds to an area just west of the Never Summer Range near Rand, Colorado. The moose have prospered and have migrated into the park; the headwaters of the Colorado River in the Kawuneeche Valley, near the project area. This area has proven to be prime habitat (NPS 2007d).

Moose occupy a large range and forage in a variety of habitats. They prefer a mosaic of second-growth forest, openings, swamps, lakes, and wetlands. Their preferred diet consists of willow, aspen, and aquatic plants, and they browse on the new growth of trees and shrubs (leaves, twigs, and bark) (NatureServe 2010). Much of the moose's diet is found in riparian areas, similar to those found in the project area. In new growth or natural regeneration areas, like those that may be found in restoration areas, moose foraging may disrupt young stands (Edenius et al. 2002). About 91% of moose diet is willow, of which geyer willow (*Salix geyeriana*) is the favored species (NPS 2011f). Some of the other common dietary staples of moose in the Kawuneeche Valley include drummond willow, grasses, mountain alder, mountain willow, and plane-leaf willow (Dungan et al. 2010).

Moose are observed in the Grand Ditch project area on a regular basis. In 2003 and 2004, Dungan et al. (2010) conducted a study of moose foraging behavior in the Colorado River drainage on the west side of Rocky Mountain National Park. Both low-elevation and higher-elevation riparian meadows were studied, and the study area likely overlapped parts or all of the Grand Ditch project area. The study estimated that 37 to 59 individuals were present in the Colorado River drainage. It found that moose were most active in the early summer, with about 82% of their activity during the day focused on feeding. Activity levels of moose declined through the summer but resumed with the onset of breeding season. The peak feeding times of moose are around dawn and dusk (Dungan et al. 2010).

Other Ungulates. In addition to elk and moose, two other ungulates occur in Rocky Mountain National Park: mule deer (*Odocoileus hemionus*) and bighorn sheep (*Ovis canadensis*). These ungulates are spatially segregated for part of the year. Mule deer occur throughout the park in the summer but in winter are most often found on the east side of the park, and bighorn sheep are found in several mid- to high-elevation areas throughout the course of the year. Mule deer occur in the project area, and bighorn sheep may also occur but generally tend to use rockier habitat uphill of the project area.

Mule deer occupy many types of habitats in mountains and lowlands, including various forests and woodlands, forest edges, shrublands, grasslands with shrubs, and residential areas. Mule deer browse on a wide variety of woody plants and graze on grasses and forbs (NatureServe 2010). Similar to both elk and moose, mule deer foraging of young plants can disrupt the regrowth of disturbed areas.

Bighorn sheep typically occur in steep, high mountain terrain. In Colorado, they prefer habitat dominated by grass, low shrubs, and rock cover as well as areas near open escape. Bighorn sheep are primarily grazers, feeding in meadows, open woodland, and alpine tundra; however, they will also eat forbs (herbaceous plants) in the summer and browse in the winter. Grasses eaten by bighorn sheep include bluegrass, sedges, wheat grass, bromes, and fescues. Browse includes willow, mountain mahogany, winterfat, and bitter brush. Forbs include clover, cinquefoil, and phlox. Lambing season is from April through July, with the peak in late May and early June (Colorado Division of Parks and Wildlife 2010a). In the park, bighorn sheep occur in alpine areas and also descend from the Mummy Range into Horseshoe Park and lower elevations during the summer

(NPS 2007b). Though the sheep are not likely to frequently occur in the project area, they may be affected by construction activities and possible helicopter overflight.

Birds

Over 300 bird species have been observed in the Rocky Mountain National Park area. Birds in the park include year-round residents, seasonal migrants and breeders, and occasional visitors. The large majority of these birds are seasonal residents; only 26 species are considered common, year-round inhabitants of the park. Twenty-two bird species of continental importance, as identified by the Partners in Flight North American Landbird Conservation Plan (Rich et al. 2004), have been documented in Rocky Mountain National Park. Of these 22 species, 15 are known to breed in the park, though several are only known to migrate through the park in the spring and fall. The black swift (*Cypseloides niger*) and the brown-capped rosy finch (*Leucosticte australis*) have very important breeding habitat in the park. Rocky Mountain National Park has an important role in the long-term sustainability for all of these species. Birds in the park that could be affected by Grand Ditch breach restoration activities include songbirds/neo-tropical migrants, raptors, waterfowl, and shorebirds.

Songbirds. At least 150 species of songbirds have been observed in the park. About one-third of these are neotropical migrants, defined as birds that spend the winter south of the United States or Tropic of Cancer (Connor 1993). Many neotropical migrants and songbirds breed in the park (Johnsgard 1986). The diversity of songbirds and neotropical migrants in the park is greatest in aspen, riparian willow, and ponderosa pine habitat (Connor 1993, Turchi et al. 1994), which combined make up only 9% of the park area. The Kawuneeche Valley contains 9% of the park's aspen and willow riparian habitat. These areas are the only large, continuous areas of such habitat.

Riparian habitats support the highest bird diversity of any western habitat type, while being one of the rarest (< 4% of the park). Dusky flycatcher (*Empidonax oberholseri*), red-naped sapsucker (*Sphyrapicus nuchalis*), rufous hummingbird (*Selasphorus rufus*), Lewis's woodpecker (*Melanerpes lewis*), and calliope hummingbird (*Stellula calliope*) occupy various riparian habitats. Bird species specifically associated with willow include Wilson's warbler (*Wilsonia pusilla*), Lincoln's sparrow (*Melospiza lincolnii*), fox sparrow (*Passerella iliaca*), song sparrow (*Melospiza melodia*), yellow warbler (*Dendroica petechia*), and white-crowned sparrow (*Zonotrichia leucophrys*). Long-term bird monitoring in willow habitat indicates that the fox sparrow disappears from willow habitat when heavy willow grazing impacts the lower half of the shrub and understory vegetation. Leukering and Carter (1999) found that different bird species in the park used different sizes and densities of willow, indicating that short and tall willow are both important.

Turchi et al. (1994) found bird species richness to be significantly higher in aspen than conifer habitat, and percent shrub cover (1.5 to 7 feet in height) within aspen stands to be the single most important predictor variable for bird species richness in the park. About 13 avian species breed almost exclusively in aspen, including Williamson's and red-naped sapsuckers, which are species of continental importance (Rich et al. 2004). Cavity-nesting species such as woodpeckers, swallows, bluebirds, chickadees, and nuthatches use live and dead standing trees, including aspen, as roosting and nesting sites. Zaninelli and Leukering (1998) and Duberstein (2001) suggest that live aspen trees are more important to cavity-nesting birds than dead trees, and that different bird species used different sizes and densities of aspen.

Raptors. Three species of accipiters—northern goshawk (*Accipiter gentilis*), Cooper's hawk (*A. cooperii*) and sharp-shinned hawk (*A. striatus*)—breed in the park. Their long tails and short, broad wings enable them to hunt in densely wooded habitat. Nests have been found in lodgepole pine and aspen, in or near small groves of aspen, and in riparian areas intermixed with dense lodgepole pine and Douglas fir within 550 yards of open meadows. A high proportion of accipiter nests in the park have been found in the elk winter range in the montane zone, primarily in the eastern part of the park; however, the project area may provide foraging habitat for the species. Their nests tend to be on north to northwest-facing slopes but have also been found on east facing slopes. The northern goshawk often hunts in open meadows where their principle prey, the Wyoming ground squirrel (*Spermophilus elegans*), is abundant. Other prey used by the three species of accipiters includes birds, chipmunks, chickaree, snakes, and other small mammals (NPS 2007c).

The prairie falcon (*Falco mexicanus*), peregrine falcon (*F. peregrinus*), American kestrel (*F. sparverius*), osprey (*Pandion haliaetus*) and red-tailed hawk (*Buteo jamaicensis)* can also be found breeding within the park. Prairie and peregrine falcons primarily hunt birds, and to a lesser degree, small mammals. American kestrels will also catch large insects such as grasshoppers and butterflies (NPS 2007c). One pair of prairie falcons nests on south- and east-facing cliffs along Trail Ridge, and another pair is suspected to use the crater at Specimen Mountain for nesting. Neither of the nest sites would be expected to be impacted by the proposed action (NPS 2011f). Ospreys are known to occur in the Kawuneeche Valley and along the Colorado River (NPS 2011d). Red-tailed hawks are the most common raptor in the park and usually nest in old-growth, live ponderosa pines, with some breeding pairs nesting on south-facing cliffs. All known red-tailed hawk nests are within the montane zone in association with ponderosa pine, aspen, and Douglas fir (NPS 2007c). Red-tailed hawks have a known presence in the Kawuneeche Valley; however, there are no documented nesting pairs in the project area or in the valley. Osprey are known to have nested in the Kawuneeche Valley, though there are presently no known active nests in the area after the nest in Bowen Baker area was destroyed when the tree was killed by mountain pine beetle (NPS 2011f).

Turkey vultures (*Cathartes aura*) occur in the park, but there is no documentation of any vultures nesting in the park. There are six to twelve known vultures in the park that roost at Lake Estes, and sometimes Lumpy Ridge, but there are no known roosts in the Kawuneeche Valley (NPS 2011f). Turkey vultures are scavengers and have been observed feeding on the carcasses of elk, deer, and bighorn sheep. They roost and nest on cliffs, but nests could also be in hollow logs. They do not build nests, but use scrapes in gravel, or needles and leaves in a log (NPS 2007c).

Golden eagles are known to breed in the park and are observed fairly frequently. Golden eagles occupy a variety of habitats, though they prefer open terrain and are not often found in heavily forested areas (Peregrine Fund 2011). They feed primarily on small mammals. Prey remains of bighorn sheep lambs have been found in nests, and while golden eagles could take elk, especially calves, predation on elk has not been documented in the park (NPS 2007c).

Waterfowl. Four species of waterfowl—the mallard (*Anas platyrhynchos*), green-winged teal (*Anas crecca*), ring-necked duck (*Aythya collaris*), and Canada goose (*Branta canadensis*)—frequently nest in the park. Primary nesting habitat includes the shoreline of beaver ponds, small ponds, and lakes. They occasionally nest along the banks of rivers and streams. Nests are located in dense sedges that grow 1.5 to 3 feet in height along shorelines or may also be found in understory vegetation beneath willow. Young-of-the-year ducklings and goslings rely on dense aquatic vegetation along the edges of ponds and lakes that provide feeding habitat and protective cover from predators. Other species of waterfowl are migrants moving through the park during the spring and fall. The common merganser (*Mergus merganser*), common goldeneye (*Bucephala clangula*), and rarely the hooded merganser (*Lophodytes cucullatus*), red-breasted merganser (*Mergus serrator*), and Barrow's goldeneye (*Bucephala islandica*) can be found during the winter feeding and roosting in open water along flowing streams (NPS 2007c). Canada geese nest in the park, but infrequently (NPS 2011f).

Only two species of shorebirds, spotted sandpiper and killdeer, are known to nest in the park. Spotted sandpipers nest in depressions in dense grass, sedges, or gravel near the shoreline of beaver ponds, lakes, and streams. Killdeers nest in open, sparsely vegetated, upland habitat in meadows.

Other species of shorebirds are migrants, passing through the park in the spring and fall, and can be found in association with riparian habitat, wetland meadows, and exposed mudflats in beaver ponds or other small ponds (NPS 2007c).

Small- to Medium-sized Mammals

Small- to medium-sized mammals in the park include the deer mouse (*Peromyscus maniculatus*), montane vole (*Microtus montanus*), least chipmunk (*Neotamias minimus*), Uinta chipmunk (*Neotamias umbrinus*), chickaree (*Tamiasciurus douglasii*), Wyoming ground squirrel (*Spermophilus elegans*), golden-mantled ground squirrel (*Spermophilus lateralis*), Abert's squirrel (*Sciurus aberti*), northern pocket gopher (*Thomomys talpoides*), Nuttall's cottontail (*Sylvilagus nuttallii*), snowshoe hare (*Lepus americanus*), pika (*Ochotona princeps*), and yellow-bellied marmot (*Marmota flaviventris*), and beaver (*Castor Canadensis*). Small mammals in the park are found in a variety of habitats (NPS 2007c).

Beaver, a keystone species, have profound effects on ecosystem structure and function (Naiman et al. 1988) and have been identified as a focal species for the NPS Inventory and Monitoring Vital Signs Program. Beaver modify their environment by cutting aspen and willow for food and construction material, by building dams that raise the water table, and by building ponds that trap sediment and increase nitrogen availability to willow (Naiman et al. 1988; Baker and Hill 2003). Beaver dams slow water velocity, increase deposition and retention of sediment and organic matter in their ponds, reduce downstream turbidity on floodplains, increase the area of soil-water interface, elevate the water table, change the annual stream discharge rate by retaining precipitation runoff during high flows and slowly releasing it during low flows, alter stream gradients by creating a stair-step profile, and increase resistance to disturbance (Naiman et al. 1988). Beaver foraging can alter species composition, density, growth form, and distribution of woody vegetation.

Beaver dams and ponds on the Colorado River in the Kawuneeche Valley greatly enhance the depth, extent, and duration of inundation associated with floods (Westbrook et al. 2006). Beaver dams raise the water table during periods of high and low flows and spread water laterally and downstream to locations out of reach of spring floods or other hydrologic processes (Westbrook 2005, Westbrook et al. 2006). Each beaver dam studied eased the water table decline that occurs in drier summer months over nearly one quarter of the 143-acre study area (Westbrook et al. 2006).

Willows provide an important source of food and construction material for beaver. Willow leaves are high in protein content and are readily eaten during the summer. The bark of willow stems may be the only source of winter food for beaver that live in locations where surface water freezes during winter (Baker and Cade 1995). Beaver are central place foragers that cut and remove entire stems at or near the ground surface. They often cut all stems from preferred shrubs growing near their winter food caches, dams, and lodges, but become more selective as foraging distances increase (Baker and Hill 2003). Beaver in the park prefer relatively tall, unbrowsed willow and select against short, hedged willow (Baker, Ducharme, et al. 2003). Thus, willow communities in the park that have been hedged short by ungulates are largely unsuitable as beaver habitat. Additionally, a rapid willow decline in the Kawuneeche Valley has contributed to declining habitat for beavers in the park.

Beaver populations in the park have declined dramatically since 1940, and current data suggest they are currently rare. In the Kawuneeche Valley, beaver numbers were estimated to be about 60 in 1949 and only 30 in 1999 (Mitchell et al. 1999). Surveying efforts from 2009 and 2010 (Scherer et al. 2011) indicate that beaver occupy only 10% of the most suitable streamside habitat in Rocky Mountain National Park. This figure, however, is based on a habitat suitability map suspected overestimate habitat because beaver appear to require willow of at least 10 feet in height and the map was based only on the presence or absence of deciduous shrubs and trees with no consideration of the height or abundance of shrubs and trees. In 2009, beaver occupancy was detected in two plots in the

Kawuneeche Valley near the Red Mountain area, south of the project area. No 2010 observations were made in the valley (Scherer et al. 2011).

Predators and Scavengers

Potential predators in the park and surrounding areas include mountain lion (*Felis concolor*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), black bear (*Ursus americanus*), gray wolf (*Canis lupus*), and golden eagle (*Aquila chrysaetos*). The grizzly bear (*Ursus arctos*) is a native predator; however, it no longer occurs in the area, having disappeared soon after the park was established (Armstrong 1987). Predator populations in the park were controlled from 1917 to 1926 to encourage recovery of ungulate populations, with records of approximately 50 coyotes and 20 mountain lions eliminated (Stevens 1980).

It is not known how many mountain lions inhabit the park; however, they are observed fairly frequently. They are most abundant in broken country with good cover of brush or woodland. In the park and surrounding areas, mule deer are their primary prey; however, they occasionally take elk (Armstrong 1987).

Coyotes are common in the park. They are highly adaptable animals and range through a wide variety of habitats. Coyotes have a broad diet that consists principally of small- to medium-sized mammals and some birds (Armstrong 1987). During winter, scavenging can be important.

Bobcat are considered common in the park. They occur in woodland, shrubland, and forest-edge habitat throughout the park. The primary prey of bobcats consists of rabbits, hares, and a variety of other small mammals and birds (Armstrong 1987; Bear 1989).

Black bear are strongly tied to forested habitats (Rogers 1976; Powell et al. 1997). They are omnivorous, eating plant and animal matter, and primarily scavenge (Knight et al. 1999, Smith and Anderson 1996). In general, the park provides poor to marginal black bear habitat, and bear densities are relatively low, bears are small, and cub survival is low relative to other populations in Colorado (Zeigenfuss 2001; McCutchen et al. 1993). The population size in the park is estimated to be 20 to 25 bears (Zeigenfuss 2001).

A gray wolf was videotaped by a biologist for the Colorado Division of Parks and Wildlife in 2007, about 10 miles south of the Colorado-Wyoming border near the town of Walden (Colorado Division of Parks and Wildlife 2010b), approximately 30 miles northwest of the project area. Also in December 2007, a wolf was observed in the park and tracks were noted until March 2008. The documentation of a wolf was never confirmed in the park, however. Two female wolves have been documented in Colorado in recent years, both migrating from the Greater Yellowstone area. One of them spent some time in the North Central mountains, which include Rocky Mountain National Park (NPS 2011f). As of this writing, the gray wolf is not considered to be present in Rocky Mountain National Park, but the future potential for its presence is relatively high given expansion of the reintroduced Greater Yellowstone population and recent sightings in the region.

Scavengers in the park include black bear, coyote, mountain lion, bobcat, red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), common raven (*Corvus corax*), gray jay (*Perisoreus canadensis*), Steller's jay (*Cyanocitta stelleri*), black-billed magpie (*Pica hudsonia*), and turkey vultures. Bald and golden eagles have been observed feeding on elk carcasses (NPS 2007c).

Amphibians and Reptiles

In Rocky Mountain National Park, historical records include observations of leopard frogs (*Rana pipiens*), boreal toads (*Bufo boreas*), boreal chorus frogs (*Pseudacris maculata*), wood frogs (*Rana sylvatica*), western chorus frogs (*Pseudacris triseriata*), and tiger salamanders (*Ambystoma tigrinum*).

Despite considerable survey effort beginning in 1988, the northern leopard frog has not been observed in the park and is presumed to be extirpated. Boreal chorus frogs and tiger salamanders are both known to occur in the upper Kawuneeche Valley (Scherer 2010; NPS 2007c). The Grand Ditch and a large reduction in the abundance of beaver have changed hydrologic conditions in the Kawuneeche Valley and have likely fragmented the landscape for amphibians by replacing wetlands and areas of saturated soils with more xeric areas such as dry meadows (Scherer 2010). Therefore, the amphibian population in the valley has declined through the years.

Amphibians generally prey on invertebrates, though some may eat small vertebrates. The only known reptile in the park is the western terrestrial garter snake (*Thamnophis elegans*). The garter snake frequents riparian habitat (NPS 2007c).

Boreal toads and wood frogs are discussed in the "Special Status Species" section.

AQUATIC SPECIES

Fish

As discussed in the "Special Status Species" section, native fish species that occur in the park are greenback cutthroat trout and Colorado River cutthroat trout. Other native fish species found in the Upper Colorado River basin include mountain sucker (*Catostomus platyrhynchus*; west slope), western longnose sucker (*C. catostomus griseus*), western white sucker (*C. commersoni suckii*; may be introduced in west slope waters), and mottled sculpin (*Cottus bairdi*). Exotic fish that occur in the park are brown trout (*Salmo trutta*), eastern brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*), and Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*).

Fish surveys were conducted by the U.S. Fish and Wildlife Service in the restoration area before and after the 2003 breach event. The Colorado River near Lulu City was surveyed in 1999 (Kennedy 2003), shortly after the breach in October 2003 (Kennedy 2003), and in 2005 and 2008 (Kennedy 2008 and 2009; Kennedy and Rosenlund 2011). The U.S. Fish and Wildlife Service surveyed the Lulu City fish trend site on the Colorado River a short distance upstream of the Lulu City wetland in 1999. Fish surveys were first conducted in the two main branches of the Colorado River (noted as the East Branch and the West Branch) in the Lulu City wetland in 2009 and 2010 (Kennedy 2010; Kennedy and Rosenlund 2011). The results of these surveys are presented in table 3.8 for both the Colorado River above the wetland and the Colorado River in the Lulu City wetland.

The Lulu City fish trend site survey results indicate that the brook trout is the dominant trout species in the Colorado River upstream from the Lulu City wetland, comprising more than 97.3% of all fish captured in 1999 and 75.6% of all fish captured in October 2003 in the Colorado River upstream of the wetland. The Colorado River cutthroat trout was the only other species captured during these two periods. The increase in Colorado River cutthroat trout abundance in 2003 was attributed to individuals being washed into the Colorado River from the Grand Ditch during the breach event (Kennedy 2003). Subsequent stream sampling since 2003 showed a decrease in Colorado River cutthroat trout abundance to levels similar to those present before the breach. Stream sampling in 2009 produced two brown trout in the Colorado River in the Lulu City wetland, which is the first reported occurrence of this species this high in the watershed (Kennedy and Rosenlund 2011).

The first fish sampling in the Colorado River reaches flowing through the Lulu City wetland occurred in 2009 and 2010. Brook trout comprised more than 99.9% of all fish greater than or equal to 100 millimeters in length captured in the wetland area. One Colorado River cutthroat trout and two brown trout comprised the other trout captured (Kennedy and Rosenlund 2011).

The results of the October 2003 stream sampling at the Colorado River Lulu City fish trend site several months after the breach event of May 30, 2003 revealed that the brook trout population and biomass estimates were greater than levels that were estimated in September 1999 (table 3.8). Kennedy (2003) did not comment on potential effects of the breach on fish population in the restoration area, but he did note that sedimentation of the fish trend site had not occurred. However, follow-up surveys in 2006 and 2008 at the Colorado River Lulu City fish trend site (Kennedy 2006, 2008) documented about twice the 2003 brook trout biomass and about three times the population numbers compared to the 1999 and 2003 levels. Kennedy and Rosenlund (2011) attributed the large increase in brook trout abundance to an increase in available habitat within the survey reach, caused by the flood waters from the breach. While no habitat data existed for this site it appeared that a large lateral scour pool near the downstream end of the reach became larger and scoured deeper into the bank. In addition, deeper water with more undercut bank existed near the upper end of the reach. It appeared that the breach increased available fish habitat, and improved conditions for fish within this section of the Colorado River.

During the 2009 and 2010 sampling of the Lulu City wetland branches of the Colorado River, Kennedy and Rosenlund (2011) noted that because there were no previous fish surveys through Lulu Meadow (the Lulu City wetland) prior to the breach, definitive conclusions on the effects of the breach to fish populations could not be made. However, based upon the 2009 and 2010 fish survey results, there was an abundance of fish throughout the Lulu City wetland even in areas where obvious sedimentation had occurred. Any differences, therefore, between pre- and post-2003 breach in fish abundance were most likely related to available habitat, not to impacts of the breach (Kennedy and Rosenlund 2011).

Table 3.8: Summary of Fish Sampling Results for the Colorado River at Lulu City Trend Site and for the Lulu City Wetland

Species Results	1999		2003		2006		2008		2009		2010	
	CR (1)	LCW (2)	CR	LCW	CR	LCW	CR	LCW	CR	LCW	CR	LCW
Brook Trout												
Number of Fish Captured	73	--	68	--	385	--	226	--	--	--	--	2,235
Population (fish per mile >100 mm long)	915	--	1,128	--	3,310	--	3,489	--	--	1,864	--	1,497
Biomass (pounds per acre)	54	--	74	--	151	--	150	--	--	131	--	95
Colorado River Cutthroat Trout												
Number of Fish Captured	2	--	22	--	3	--	1	--	--	1	--	--
Population (fish per mile >100 mm long)	--	--	--	--	51	--	14	--	--	--	--	--
Biomass (pounds per acre)	--	--	--	--	7	--	--	--	--	--	--	--
Brown Trout												
Number of Fish Captured	0	--	0	--	0	--	--	--	--	2	--	--
Population (fish per mile >100 mm long)	--	--	--	--	--	--	--	--	--	--	--	--
Biomass (pounds per acre)	--	--	--	--	--	--	--	--	--	--	--	--

Sources: Kennedy 2003, 2006, 2008, 2010; Kennedy and Rosenlund 2011.

(1) CR = Colorado River at Lulu City Trend Site.

(2) LCW = Lulu City wetland, includes only East Branch in 2009 and East and West Branches of Colorado River in 2010.

Macroinvertebrates

Stream macroinvertebrate assemblages are largely influenced by the stream habitats. Substrate, water velocity and depth, and input of organic matter influence the distribution and species composition of macroinvertebrates at small scales such as between riffles and pools. Macroinvertebrate assemblages adapt to a wide range of environmental disturbances and a specific species assemblage associated with a stream location can be used as a biomonitoring tool to evaluate the health of aquatic environments (Flotemersch et al. 2006). In high-mountain streams of Colorado with good water quality and high water velocities there are assemblages of caddisflies (Trichoptera), stoneflies (Plecoptera), and mayflies (Ephemeroptera) that have evolved to exist in these conditions. In lower-gradient streams or areas within streams such as pools, midges (Chironomidae) and other varieties of flies (Diptera) can be found. In wetlands where streamflow is generally slow, there is a shift in macroinvertebrate assemblages to those species that are highly mobile as they move about searching for food. Common macroinvertebrates found in wetlands are dragonflies and damselflies (Odonata), beetles (Coleoptera) and true water bugs (Hemiptera) such as water striders.

Sedimentation into streams can have a profound effect on macroinvertebrate assemblages. Inorganic sediment loads increased over quantities or frequencies that occur naturally can impact the stream macroinvertebrate assemblages in many ways. Extreme levels of streambed transport may greatly reduce primary production, which is a food source for many aquatic macroinvertebrates, and extremely high bedload transport increases mortality rates for taxa living on the channel bed (Nislow et al. 2002). The insects of mountain streams can withstand normal variations in discharge and resultant changes in suspended sediment loads, although alterations induced by humans, such as the Grand Ditch breach, may have devastating effects on benthic macroinvertebrate fauna (Ward and Kondratieff 1992). Increased turbidity by suspended sediments and decreased channel bed stability due to high flows can temporarily reduce stream primary production by reducing photosynthesis, physically abrading algae and other plants, and preventing attachment of autotrophs (photosynthesizing producers) to substrate surfaces (Brookes 1986; Wood and Armitage 1997). Decreasing primary production can affect many other organisms in the stream food web. Those organisms such as caddisflies and mayflies that graze on top of rocks and in streams would be unable to feed as a result of increased sedimentation. High streamflow events with concurrent releases of sediment from channel bed or streambank sources, whether a natural or a human-exacerbated occurrence, can temporarily disrupt or fragment populations and community assemblages of macroinvertebrates. Disturbed sites are typically re-colonized by individuals of adapted species that drift into the affected areas from upstream locations once the disturbance is over.

Aquatic macroinvertebrates are affected by habitat reduction and/or habitat change resulting in increased drift, lowered respiration capacity (by physically blocking gill surfaces or lowering dissolved oxygen concentrations), and changing the efficiency of certain feeding activities especially filter feeding (such as by Hydropsyche spp. caddisflies) and visual predation (Lemly 1982). Substratum has been found to be a primary factor influencing the abundance and distribution of aquatic insects (Minshall 1984). Aquatic detritivores also can be affected when their food supply either is buried under sediments or diluted by increased inorganic sediment load and by increasing search time for food.

In a study conducted in a section of the upper Colorado River in the park in 2003, Clayton and Westbrook (2008) observed lower levels of periphyton due to a shorter duration of bed stability and longer duration of decreased light availability to the channel bed because of suspended sediment loads. However, they observed an increase in population levels of invertebrate taxa that included caddisflies, mayflies, and stoneflies, which they hypothesize resulted from a greater inundated channel area providing more overall benthic habitat. Because the study did not evaluate to the species level, no determination was made whether there was a trophic shift in the benthic population as a result of change in food availability.

Although specific surveys of the macroinvertebrates in the project area have not been conducted, it is probable that the benthic assemblages, particularly in Lulu Creek (zone 2) and the Colorado River (zone 3), were altered during the 2003 breach, which would be considered an extreme flow event. It is suspected that the abundance and distribution of autotrophs and those macroinvertebrate species that prefer clear water (such as stoneflies and some mayflies) would have shown temporary declines in population levels after the breach. Populations would continue to fluctuate with high levels of streambank erosion associated with subsequent high flow events such as those in 2010 and 2011. Because of dramatic changes in channel bedload and other geomorphic conditions after the breach, the macroinvertebrate species composition and populations in zones 2 and 3 probably have been fluctuating more widely than they otherwise would have had the breach not occurred.

CULTURAL RESOURCES

INTRODUCTION

Prehistoric Background

Rocky Mountain National Park has been the home to Native Americans for at least the last 12,000 years. The remains of all the known prehistoric cultures except Folsom (ca. 10,000 to 8000 years ago) have been found in the park. The basic prehistoric sequence is Clovis (11,000 to 10,000); Folsom; Early, Middle and Late Archaic (7,500 to 2,000); and the Early, Middle, and Late Ceramic cultures (2,000 to 300) (NPS 2011g). Around approximately 8000 BC, high-altitude regions such as the park were habitable on a regular basis. Fieldwork at higher elevations south of the park has indicated evidence of camp sites and large game drive systems estimated to date between 3850 and 3400 BC (Buchholtz 1983). The west side of the park receives more precipitation than the east side, meaning that snowfall begins earlier and snowpack melts later. As a result, year round occupancy in the Kawuneeche Valley was rare in both prehistoric and early historic times (Butler 2005).

The two tribal groups most closely associated with land within the park are the Ute and Arapaho. The Utes may have migrated from the Great Basin or the mountainous regions of Colorado. Ancestors of the Ute are believed to have been present in the Colorado Mountains for at least 6,000 years. Due to the high altitude and severe winters, occupation for these hunter-gatherers in the park was confined to the warmer months. Major occupation may have been in the autumn, when the high-altitude elk game drives were in operation. Present evidence indicates that winter occupation was at lower altitude along the Front Range and in Middle and North Parks (NPS 2011g). Buchholz (1983) provides the following description of the Utes:

> The Utes have been termed “central based wanderers” since they did not rely upon agriculture and had to travel to hunt or gather their food. Winter might find several families camped together, but springtime would start small bands on familiar trails toward hunting grounds, berry patches, or the like. Small family units hunted together, living off land that could not support large populations. They stalked deer or antelope or snared jackrabbits. They also dug roots and picked berries when those items became available. Their shelters consisted of both bison-hide tipis and brush-covered wickiups. Permanent dwellings were unnecessary since these people were nomadic. Their quest for food tended to separate the Utes into several bands during most of the year. Many families also separated from the bands to hunt or forage on their own. While food was not abundant, studies indicate that these people were probably not preoccupied by an endless task of food acquisition. Scholars do believe, however, that all bands of Utes knew times of great hunger (Buchholtz 1983).

Meanwhile, although they arrived at the park much later (approximately late 18th century), at least three dozen place names in the park are of Arapaho origin. Buchholtz (1983) describes the Arapaho:

> Living on the Great Plains over the period of several generations, the Arapaho became the apex of mobile, nomadic hunters. They excelled at horse riding; they were skilled at hunting bison, using the technique of driving herds off sharp-edged cliffs. These "buffalo jumps" allowed the Arapaho to turn a mass slaughter into a vast butchering site. Working upon the slain animals, the Arapaho could obtain hides for their tepees, bone for their tools, sinew for their thread, leather for their clothing, and food for their stomachs. Arapaho life centered around the hunt. And, at the beginning of the nineteenth century, the plains and mountains of Colorado supplied an abundance of their quarry. But it is probably their invasion of hunting grounds traditionally used by the Utes that brought them into a conflict with those older residents (Buchholtz 1983).

“The park is in possession of relatively little material remains, primarily ceramic and lithic, that can be used to define cultural groups. The outcome of this is that much of the abundant archaeological material from within and around the park is of very limited value in determining which historically known tribal groups were present in the park at any given time or their relation to the prehistoric populations of the plains and mountains" (Brett 2003). Nevertheless, fieldwork shows that small amounts of artifact material can be found throughout the park region.

Historic Background

By about 1880, the Ute had been moved to reservations in Colorado and Utah, and the Arapaho to Oklahoma and Wyoming (NPS 2011g). Euro-Americans' presence in the area only slightly overlapped that of the Native Americans, as white men did not reach the park until the 19th century. Major Stephen H. Long, the explorer for whom the famous peak is named, did not actually enter what is now the park; his 1820 expedition merely observed the mountain from afar. In 1843, Rufus Sage provided the first written account from within what is now the national park (NPS 2011g). "Sage's account of his visit also includes broad descriptions of the geology, plants, and animal life, hunting, and comments on the beauty and tranquility of the area. He does not mention any evidence of Indian use of the area, nor those of fur trappers. To date, no sites or artifacts attributable to Sage's visit, or any other fur trapper, have been found" (Butler 2005). However, many accounts of the initial settlement of the area include conversations with fur trappers who remark on having traversed the area that was to become the national park long before Sage's arrival (Butler 2005).

Following Sage's expedition, Joel Estes settled in the area in 1860. He and his family lived in a cabin along Fish Creek and raised cattle for six years before departing for warmer locales. However, by this point, many other settlers were arriving to form the town of Estes Park. At about the same time, near what is now Grand Lake, fur trapper Philip Crawshaw built a cabin on the west of the Continental Divide in 1857 or 1858; he is considered the first Euro-American settler in the area. As with Estes, Crawshaw was followed shortly thereafter by other settlers. Joseph Wescott opened a lodge that was to become the impetus for the town of Grand Lake by 1879 (Butler 2005).

The quest for gold and silver accelerated development in the area. Before the nearby Wolverine Mine began in 1875, settlement was limited to scattered ranches and hunting cabins. The mining and tourism industries spawned the construction of several sawmills in the area to cut timber for the growing towns of Gaskill, Lulu City, Grand Lake, and Estes Park. Lulu City was perhaps the most notable mining settlement that existed within what was to become the national park. Because it is within or adjacent to the project area, it is discussed in greater detail in the "Archeological Resources" section of this chapter. Meanwhile, mountain water turned out to be as valuable as gold. Construction of the Grand Ditch began in 1890 to divert water from the headwaters of the Colorado River and route it to lower elevations east of the Continental Divide for agricultural uses in towns such as Greeley and Fort Collins. As with Lulu City, a more in-depth discussion of the Grand Ditch follows in the "Historic Structures" section.

Settlers seeking to raise cattle or horses found little success in the park. By the turn of the 20th century, many had begun to focus their entrepreneurial efforts on the growing tourism market, converting their land into dude ranches and building cabins to house guests. At about the same time, "the growing national conservation and preservation movement, led by Theodore Roosevelt, Gifford Pinchot, and John Muir, advocated an appreciation for nature. In 1909, Enos Mills, a naturalist, nature guide, and lodge owner, championed the creation of the nation's tenth national park. He hoped that: 'In years to come when I am asleep beneath the pines, thousands of families will find rest and hope in this park.' Unleashing his diverse talents and inexhaustible energy, he spent several years lecturing across the nation, writing thousands of letters and articles, and lobbying Congress to create a new national park. Most civic leaders supported the idea, as did the Denver Chamber of Commerce and the Colorado Mountain Club. In general, mining, logging, and agricultural interests opposed it. On January 26, 1915, President Woodrow Wilson signed the Rocky Mountain National Park Act" (NPS 2011g).

ARCHEOLOGICAL RESOURCES

Lulu City was a notable 19th century mining town within current park boundaries. It was within the Lead Mountain Mining District, which contained approximately 56 total mines. The settlement started as a small gold and silver mining camp in the summer of 1879. The town's name is supposedly derived from the daughter of one of the town's founders. Within a year, a 160-acre town site had been surveyed, and a year after that, more than a dozen businesses were in place to serve the population of prospectors (Butler 2005). "Life around Lulu City, 'The Coming Metropolis of Grand County,' became ever more hectic throughout 1880 and 1881. Miners' tents dotted the valley and newly built cabins appeared 'with crowds of people and the bustle and bang of hammers and saws.' Two hundred men were reported to be prospecting and mining on the slopes nearby. 'Miners are busy doing assessment work on their claims,' one observer noted. 'Blasts can be heard at any time of the day from mines in hearing of Lulu City (Buchholtz 1983).'"

As with most mining towns, the original boom was followed by the inevitable bust. In the case of Lulu City, the duration of the boom was especially short. Miners struggled to find enough ore, and what they found was of low quality. "Plans for a 'concentrator' or smelter were never realized, and it proved too costly to ship the unrefined ore to smelters farther away [the railroad did not reach Granby until 1904]. By the fall of 1883, Lulu City was largely abandoned, and mail service ceased in November. The *Colorado Miner* reported in December that bears and mountain lions had driven off most of the remaining residents" (Butler 2005). Barely a decade after its founding, Lulu City was a veritable ghost town.

Today, the remains of Lulu City comprise an archeological site in a large meadow within a lodgepole pine forest east of the Colorado River floodplain. The land was purchased by the National Park Service in 1949, which determined to forego preservation of the site. Rather, the park has allowed nature to take its course, and it interprets the decaying ruins to park visitors through informational signage (McWilliams and McWilliams 1985). The Civilian Conservation Corps had several camps in the park during the 1930s, including one in the Kawuneeche Valley on Beaver Creek. The workers reportedly removed many old cabins, associated trash, and abandoned mining equipment, viewing these remains as trash because many of the items were just 30 to 40 years old (Butler 2005). These activities may have resulted in a loss of artifacts at Lulu City.

The Lulu City town site was surveyed and reevaluated in 2002. Findings from this survey indicated there were few archeological remains to record. The former mining town site was measured at 500 by 820 feet, and recorded surface artifacts included square nails; small, broken ceramics; bottle glass; and milled lumber (Brunswig 2002). A 2005 report indicated that, "the only visible structural remains of the former town are remnants of a log cabin, several ephemeral building platform outlines, a bear trap, and several light scatters of artifacts on the surface" (Butler 2005). The center of the site is south of Lulu Creek and east and west of the lower end of the Thunder Pass Trail, which follows the path of the town's former main street. Lulu City was listed on the National Register of Historic Places on January 29, 1988. Visible remnants of wagon roads also exist in the area of Lulu City. These include Stewart's Wagon Road and the Grand Lake–Lulu City Wagon Road, which includes the Corduroy Road.

HISTORIC STRUCTURES

One historic structure is present within the project area: the Grand Ditch. With a semi-arid climate over most of its lower elevations, along with a predominance of land used for agricultural production, water has long been a vital resource in Colorado. "Farmers living out on the parched plains east of the Rockies eyed the snowy summits, seeing not only dramatic vistas but water waiting to melt. Their soil was rich, but their prairie was dry, averaging only 15 inches of rainfall or less each year" (Buchholz 1983). Water diversion developed in the state during the second half of the 1800s as a means to route valuable water toward settled areas from melting snowpack in mountainous areas. The oldest ditch used for such large-scale water diversion was constructed in the San Luis Valley in 1852. The Grand Ditch, which is now within park boundaries, diverts water toward the eastern plains that would ordinarily flow into the Colorado River and westward toward the Western Slope and on to the Pacific Ocean. It was placed on the National Register of Historic Places in 1975, and a revision to the nomination reportedly will include all the camps and associated sites as a National Register Historic District (Butler 2005).

"Construction on the Grand Ditch began in 1890 with the use of hand labor and probably horse-drawn Fresno scrapers to dig the approximately 10-foot- wide ditch" (Butler 2005). "According to historian D. Ferrel Atkins, this project was one of the largest of all the early engineering efforts to divert water from the western slope and send it eastward. La Poudre Pass in the northwest corner of today's Park at an elevation of 10,175 feet above sea level was seen as a perfect focal point for diversion canals. According to the plan, water from melting snow could be caught in ditches carved along the contour of the mountainsides. Those canals could be angled slightly downward toward La Poudre Pass. Once those canals emptied their liquid cargo into Long Draw Creek [La Poudre Pass Creek], the eastern flow of the Cache la Poudre River would do the rest. With that basic plan in mind, the Larimer County Ditch Company was formed in 1881. Work got underway and on October 15, 1890 the first diverted water moved across La Poudre Pass heading east" (Buchholz 1983).

"Construction was apparently carried out intermittently for the next 3 decades, and seven construction camps were established along the route to house construction workers and equipment: Camps 1 through 6 between 1890 and 1911. Work on the ditch ceased in 1911, and did not resume until 1934 when the ditch company decided to extend the ditch to Baker Gulch to maintain water rights. The last six miles of the ditch was completed with heavy machinery. The Grand Ditch was finished in 1937 (Butler 2005)."

"Visually, the Grand Ditch made a 14.3-mile scar while the [nearby] Specimen Ditch was largely concealed from public view. Although both projects 'stole' water from the Grand (later Colorado) River, demands for water simply outweighed any concern about unsightliness or the disruption of natural watercourses. Future problems caused by dumping water into unnatural drainages, erosion, scarring, landsliding, seepages, and other damages created by such an ambitious project were largely ignored until the 1960s, when critics began expressing concern. Clearly, aesthetics were less important than water in the 1890s. Getting water for farms meant that nature must yield. Water remained something to be diverted, dammed, stored, sold, and used" (Buchholz 1983). The Grand Ditch transfers up to 30,0000 acre-feet of water on a yearly basis from the east slope of the Never Summer Range (Colorado River drainage) to the Cache La Poudre (Butler 2005), with diversion dependent upon annual snowfall levels.

VISITOR USE AND EXPERIENCE

INTRODUCTION

Rocky Mountain National Park covers 265,758 acres in northern Colorado. The park's 3,128,446 visitors in 2010 ranked sixth among national parks for total visitation. From 2001 to 2010, visitation averaged 3,070,603, with a peak of 3,318,309 visitors in 2001 and a low of 2,927,921 in 2006 (NPS 2011c). As shown in figure 3.13, the number of monthly visits hovers around the 50,000 to 75,000 mark during the offseason months of November through April, then incrementally rises in May and June before peaking in July (699,101 visits in 2010) and then slowly tapering over the next three months (NPS 2011h).

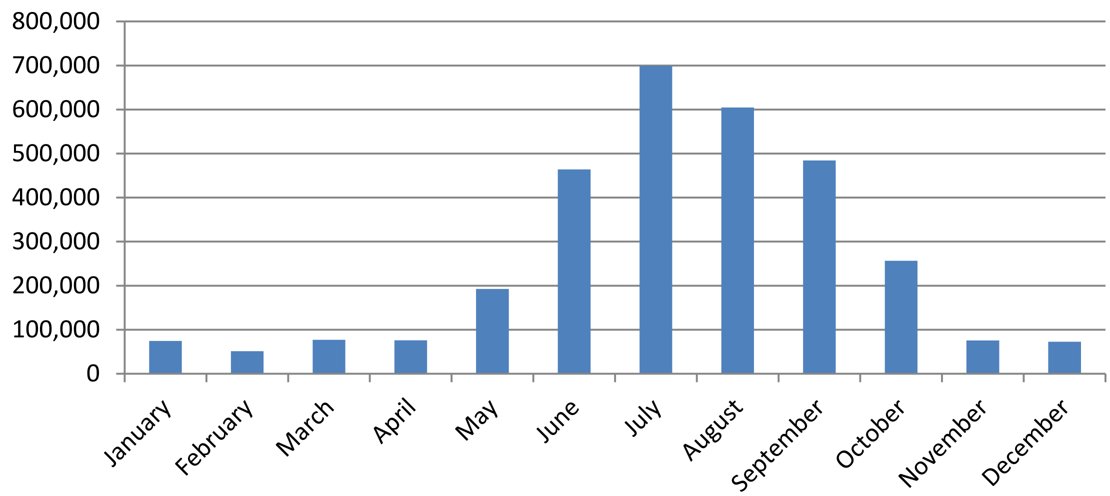

Figure 3.13: Average Rocky Mountain National Park recreation visits by month, 2010

Approximately 70% of visitors access the park through the east entrance, near the town of Estes Park (NPS 2004c). The town offers a wide range of tourist attractions, including hotels, restaurants, shops, golf, wildlife viewing, and special events. Another 15% enter at the west entrance near Grand Lake, and the remaining entrances admit the remaining 15% of visitors (NPS 2004c). Near the park's west entrance, visitors can enjoy four major reservoirs at the Arapahoe National Recreation Area or visit Grand Lake, the largest glacial lake in Colorado. Approximately 500,000 Rocky Mountain National Park visitors make the trip from Estes Park to the Grand Lake area each year when Trail Ridge Road is open, generally late May to early October (Town of Grand Lake 2005).

Among the park's primary attractions for visitors are its scenery and wildlife. A survey during the summer of 2010 found that 96% of visitor rated native wildlife as an extremely or very important park feature and 95% of visitors rated natural scenery/undeveloped vistas as extremely or very important (NPS 2010c). The same survey indicated that the three most common activities while visiting the park were to view scenery (93%), to drive Trail Ridge Road (75%), and to view wildlife (73%) (NPS 2010c).

However, popular summer activities include not only viewing wildlife and scenery but also hiking, camping, climbing, fishing, mountaineering, and horseback riding. Wintertime activities include viewing scenery, wildlife viewing, and snowshoeing (NPS 2011i).

The project area is served by the Colorado River Trailhead network, which includes the Little Yellowstone, Thunder Pass, Skeleton Gulch, Lulu City, and Grand Ditch trails (figure 3.14). These trails are primarily of moderate difficulty. A one-way hike from the Colorado River Trailhead at Trail Ridge Road to Lulu City takes visitors 3.7 miles with an approximate elevation gain of 350 feet (NPS 2011b). Further explorations along the spur trails can increase one-way distances close to 5 miles, with elevation gains approaching 1,000 feet. The network also connects to the Grand Ditch Trail, which extends for 11.4 miles (Resource Analysis Systems 2011). Visitors during winter months use the Colorado River Trail for ski touring and snowshoeing. The 7.4-mile round trip to the Lulu City site and back is of moderate difficulty, and the trailhead offers the last open parking area before the winter closure of Trail Ridge Road.

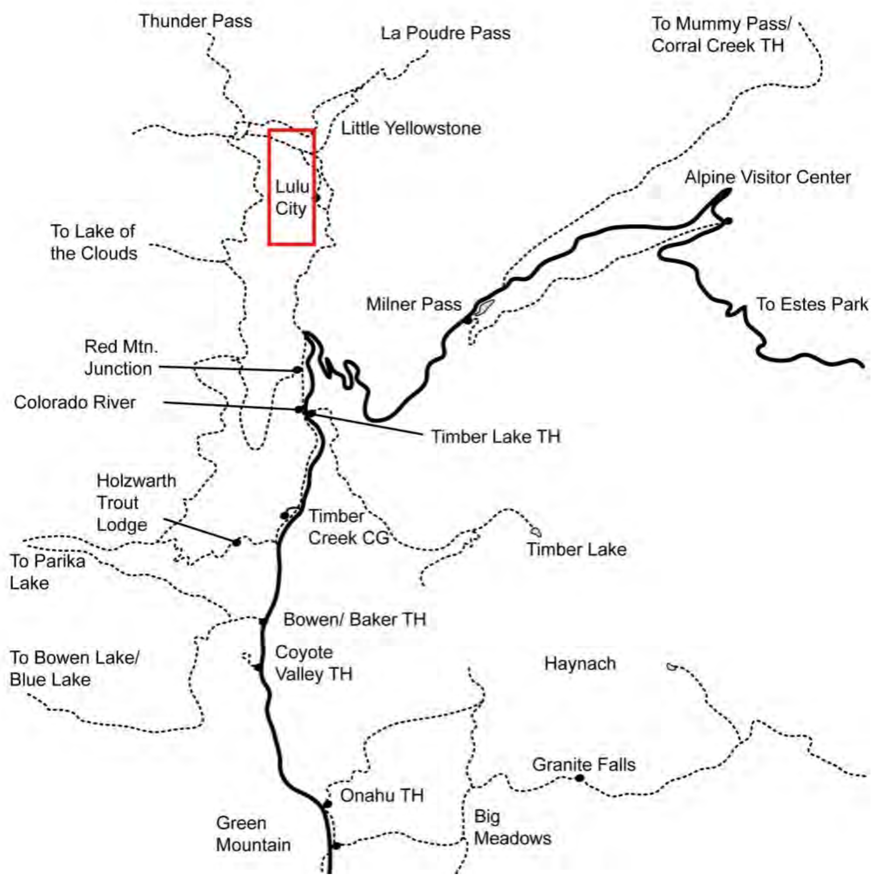

Figure 3.14: Kawuneeche Valley hiking trails (project area highlighted in red)

In addition to hikers who traverse the project area, backcountry camping occurs within and near the project area. Camping within the project requires a backcountry permit that can be obtained at any ranger station within the park. There are several backcountry campsites within the Kawuneeche Valley and two dispersed camping areas close to the project area. Due to unsafe conditions resulting from beetle kill in the area, the Stage Road site (site 108) has been closed, and the area has been converted to a backcountry camping zone. In 2010, backcountry campers used sites in the Kawuneeche Valley for a total of 721 user nights (NPS 2011e). (Two campers using one site for three nights would constitute six user nights.)

Those hiking and camping within or near the project area are in either a Class 1 or Class 3 wilderness area (see the "Wilderness" section in this chapter) and therefore generally expect degrees of solitude and natural quiet that are associated with wilderness areas (see the "Wilderness" and "Soundscapes" sections in this chapter).

PARK OPERATIONS

Management of the park is broken into five divisions: Administration, Facility Management, Resource Stewardship, Interpretation, and Resource Protection and Visitor Management. All divisions are overseen by the park superintendent. Park staff work throughout the park managing visitors, resources, activities, and facilities, which include two park museums and five visitor centers (Beaver Meadows, Fall River, Kawuneeche, Alpine, and Moraine Park). As of 2010, the park staff consisted of 444 employees, with 184 permanent and term employees and 260 seasonal employees. The park also benefitted from 1,699 volunteers in 2010 (NPS 2011h). On an annual basis, the majority of park funding typically comes from short-term projects; therefore, the number of annual employees and volunteers fluctuates accordingly. The divisions directly related to the Grand Ditch restoration project are Resource Stewardship, Facility Management, and Resource Protection and Visitor Management.

RESOURCE STEWARDSHIP

The Resource Stewardship Division conducts wildlife management activities, site restoration, fire management, park planning, exotic plant control, and biological monitoring throughout the park and extending into Estes Park and Grand Lake. This group also coordinates the work of outside scientists who conduct formal studies within the park, such as chemists, hydrologists, biologists, social scientists, and archeologists.

Staff from the Resource Stewardship Division, Resource Protection and Visitor Management Division, NPS Washington Office Environmental Quality Division, and a team of cooperating researchers have conducted surveys, starting in the summer of 2003, to assess the nature and extent of the injury caused by the breach. Assessment work focused primarily on defining the footprint and the approximate depth of the deposited materials, while characterizing stream morphology, groundwater elevations, water quality, and impacts on wetland, riparian, and upland vegetation.

Since the 2008 settlement, additional assessment work has been conducted by researchers from Colorado State University (Cooper and Potter 2009, 2010; Rathburn 2009, 2010, 2011a) and the park to refine knowledge of the area's current hydrology, including stream hydrology, sediment transport, surface water-groundwater interactions, and groundwater elevations. The Resource Stewardship Division staff continues to collaborate and coordinate with experts from a variety of disciplines such as civil engineering, hydrology, ecology, and botany in the restoration of the project area.

FACILITY MANAGEMENT

The Facility Management Division is responsible for general upkeep of the park, including maintenance of park roads, park vehicles, and park facilities. Their primary tasks include snow removal, care of park buildings (plumbing, painting, carpentry, electrical), maintenance of utility systems (water laboratory), repair of backcountry bridges, care of stock animals and stables, and maintenance of trails. The facility management division provides project support for numerous infrastructure improvement projects in the park.

INTERPRETATION

The Interpretation Division staff provides information and education services at visitor centers and interpretive programs; they also write publications and create exhibits.

Interpretation programs are developed based on science, resources management, and park management goals to objectively convey the park's themes and core mission to the public. These programs include information that allows visitors to understand the relationships and importance of resource management. Interpretive rangers are expected to keep current on issues related to their presentations, which constantly evolve.

The park's periodical educational materials contain information on park resources and management. The park newspaper, a significant information resource on the status of resource management issues in the park, is published four times per year. It is available at all visitor centers and is handed out at all park entrance gates. Additional materials available at the visitor centers are produced through a cooperating association. The park website is also frequently updated with information about resource management and has included information pertaining to the Grand Ditch breach. Each interpretive program at the park integrates resource management information that reflects the themes defined in the park's comprehensive interpretive plan and various management issues. Permanent staff members meet each spring to decide the amount of interpretive programs that can be offered, based on budget, staff available, and scheduling for training (Langdon 2005).

RESOURCE PROTECTION AND VISITOR MANAGEMENT

The Resource Protection and Visitor Management Division protects park resources and the safety of park visitors. Most are law enforcement officers who perform search and rescue operations and manage activities in the backcountry as well as frontcountry roads. Law enforcement rangers are commissioned officers who police the park (including poaching, traffic control, and automobile accidents) but also provide education on the park's resources. The rangers that patrol the project area include law enforcement rangers, backcountry rangers, and wilderness rangers. The backcountry office is also responsible for issuing permits for backcountry camping and, in case of area closures, would be responsible for notifying visitors to the park that areas are not accessible by the public. The Resource Protection and Visitor Management Division also includes a wilderness crew responsible for care of backcountry campsites and mitigating pine beetle tree issues.

ADMINISTRATION

The Administration Division acts as the business office for Rocky Mountain National Park. Its principal functions include human resources, purchasing, property management, budget administration, contracting, payroll, technology support (personal computers, networks, and the park radio and telephone systems), and mail. The procurement staff within the administration division works with other division staff to create scopes of work for specific projects, solicit bids from contractors, and administer contracts.

CHAPTER 4:
ENVIRONMENTAL CONSEQUENCES

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INTRODUCTION

This “Environmental Consequences” chapter analyzes both beneficial and adverse impacts that could result from implementing any of the alternatives described in this environmental impact statement. This chapter includes a summary of laws and policies relevant to each impact topic, definitions of impact thresholds (negligible, minor, moderate, and major), methods used to analyze impacts, and the analysis methods used for determining cumulative effects. As required by the Council on Environmental Quality, regulations implementing the National Environmental Policy Act, a summary of the environmental consequences of each alternative is provided in table 2.8 in the “Alternatives” chapter. The resource topics presented in this chapter and the organization of the topics correspond to the resource discussions contained in the “Affected Environment” chapter.

SUMMARY OF REGULATIONS, GUIDANCE, AND POLICIES

Three overarching environmental protection laws and policies guide the actions of the National Park Service in the management of the park and its resources: the NPS Organic Act of 1916, the National Environmental Policy Act and its implementing regulations, and the Redwood National Park Expansion Act of 1978. For a complete discussion of these and other guiding regulations, refer to the section “Relevant Laws, Policies, Plans, and Constraints” in the “Purpose of and Need for Action” chapter. Collectively, these guiding regulations provide a framework and process for evaluating the impacts of the alternatives proposed in this environmental impact statement.

GENERAL METHODS FOR ESTABLISHING IMPACT THRESHOLDS AND MEASURING EFFECTS BY RESOURCE

The general approach for establishing impact thresholds and measuring the effects of the alternatives on each resource category includes the following elements:

- Basic assumptions used to formulate the specific methods used in this analysis
- General analysis methods as described in guiding regulations
- Methods used to evaluate the cumulative impacts of each alternative in combination with unrelated factors or actions affecting park resources
- Thresholds used to define the level of impact resulting from each alternative
- Methods used to determine if unacceptable impacts on specific resources would occur under any alternative

These elements are described in the following sections.

Geographic Extent of Impact

Unless specified otherwise, the impact analysis area includes the area directly affected by the Grand Ditch breach and areas adjacent to the restoration area within the Kawuneeche Valley within Rocky Mountain National Park. The terms used to define the extent of a particular effect or impact include the following:

Local effects of an action would affect conditions within relatively small areas within the park, such as one of the project area zones and nearby adjacent areas.

Regional effects could occur over the entire park and extend to areas outside the park.

Issues

Issues that were brought up during public and internal scoping formed the basis for developing the alternatives and for analyzing the impacts of the alternatives on each resource. The issues are presented in the "Issues and Impact Topics" section of chapter 1.

Assumptions about Restoration and about Effects of Restoration Actions

Assumptions were used to analyze the effects of Grand Ditch breach restoration actions on park resources and values. The assumptions applied to the analysis of each impact topic are presented in the "Methods and Assumptions for Analyzing Impacts" section of each impact topic.

General Analysis Methods

The analysis of impacts follows Council on Environmental Quality guidelines and *Director's Order #12* procedures (NPS 2001c).

Rocky Mountain National Park conducted surveys, starting in the summer of 2003 to assess the extent of damage generated by the Grand Ditch breach. These assessments documented the physical impacts of the flood and quantified the loss of ecological function to the uplands, riparian areas, and wetlands impacted by the flood.

In 2006, the U.S. Justice Department on behalf of the National Park Service filed a civil lawsuit against the Water Supply and Storage Company, owners of the Grand Ditch, under the authority of the Parks System Resource Protection Act. Following the settlement, additional assessment work was conducted by researchers from both Colorado State University and the park to refine knowledge of the area's current hydrology including stream hydrology, sediment transport, surface water-groundwater interactions, and groundwater elevations. These processes are compared with those in nearby reference reaches to better understand the unimpacted ecological reference conditions to be used when designing restoration of the injured area. Ground-penetrating radar was also being used experimentally to map debris and sediment deposit depths. The information from the assessments forms the foundation information upon which the impact analysis is based.

The basis for analyzing impacts differs for adverse and beneficial impacts. Adverse impacts are a loss or degradation of resource conditions compared with conditions that continue to exist following the breach. The method for determining the magnitude of an adverse impact is defined for each impact topic. The determination of a beneficial impact uses the ecological reference conditions, described in the "Alternative Development" section of chapter 2, as the analysis base and compares the environmental effects of each action alternative with those of the no-action alternative. Increasing benefits accrue from restoration actions that move resource conditions closer toward the ecological reference conditions more quickly. In all action alternatives, adverse effects from the breach would persist while restoration and recovery take place. However, due to the beneficial impacts resulting from restoration, long-term adverse effects would be lessened over time under the action alternatives when compared to no-action. As such, the lower the long-term adverse effects are, the more beneficial they are.

For each resource topic addressed in this chapter, the applicable analysis methods are discussed under the respective resource section.

Analysis Period

This environmental impact statement establishes goals, objectives, and implementation actions needed to restore the resources affected by the Grand Ditch breach in the park over many years. Each alternative would result in a different trend for restoration of ecological processes over time (see Figure 2.1 in chapter 2). Some processes and site conditions can be restored faster than others, for example, restoring willow areas to reference conditions can be substantially accomplished in 20 to 25 years, restoring channel conditions to reference conditions can be accomplished in 2 to 5 years, and restoring forested areas to reference conditions could take 200 to 350 years. Because forest restoration to the late successional stages or old-age tree classes that existed before the breach would take the longest time, none of the alternatives would achieve full restoration within 200 years. Full forest recovery might take up to 350 years. The analysis of the alternatives takes into account these various timeframes.

Decision-Making to Avoid Unacceptable Impacts on Resources of Rocky Mountain National Park

The impact threshold at which impairment occurs is not always readily apparent. Therefore, the National Park Service applies a standard that offers greater assurance that impairment will not occur. The National Park Service does this by avoiding impacts that it determines to be unacceptable. These are impacts that fall short of impairment, but are still not acceptable within a particular park's environment.

Virtually every form of human activity that takes place within a park has some degree of effect on park resources or values, but that does not mean the impact is unacceptable or that a particular use must be disallowed. Therefore, for the purposes of these policies, unacceptable impacts at Rocky Mountain National Park are impacts that, individually or cumulatively, would:

- Be inconsistent with the park's purposes or values, or
- Impede the attainment of the park's desired future conditions for natural and cultural resources as identified through the park's planning process, or
- Create an unsafe or unhealthful environment for visitors or employees, or
- Diminish opportunities for current or future generations to enjoy, learn about, or be inspired by park resources or values, or
- Unreasonably interfere with
    - Park programs or activities, or
    - An appropriate use, or
    - The atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within the park, or
    - NPS concessioner or contractor operations or services.

In accordance with *Management Policies* (NPS 2006a), park managers must not allow uses that would cause unacceptable impacts on park resources. To determine if unacceptable impacts could occur to the resources and values of Rocky Mountain National Park, the impacts of both existing and proposed actions in this environmental impact statement have been evaluated, based on the preceding criteria. Based on this analysis, no unacceptable impacts would occur as a result of implementing the actions proposed in the alternatives in this environmental impact statement.

Cumulative Effects Analysis Method

The Council on Environmental Quality regulations implementing the National Environmental Policy Act require the assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are considered for all alternatives, including Alternative A, which would continue current management practices.

Cumulative impacts were determined by combining the impacts of the alternative being considered with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other past, ongoing, and reasonably foreseeable future actions within Rocky Mountain National Park and in the surrounding region. A description of other National Park Service and other agency actions and programs is provided in the "Purpose of and Need for Action" chapter under the "Relationship to Other Projects and Plans" section. All past, present, and reasonably foreseeable future actions that are considered in the environmental analysis include the following:

- Trails Management Plan, 1982 – Ongoing
- State of Colorado Conservation Strategy for Lynx and Wolverine, 1988 – Ongoing
- Vegetation Restoration Management Plan, 2006
- Denver International Airport – Thompson Three arrival route, 1996 – Ongoing
- Resources Management Plan, 1998 – Ongoing
- Greenback Cutthroat Trout Recovery Plan, 1998 – Ongoing
- Environmental Assessment for the Management of Snowmobiles in Rocky Mountain National Park, 2002 – Ongoing
- Trail System Maintenance and Reconstruction Plan, 2000 – Ongoing
- Captive breeding program of boreal toads / Reintroduction into Rocky Mountain National Park, 2001 – Ongoing
- Conservation Plan and Agreement for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad (*Bufo boreas boreas*), 2001 – Ongoing
- Backcountry and Wilderness Management Plan, 2001 – Ongoing
- Fire Management Plan and Wildland-Urban Interface Fuels Management Environmental Assessment, 2003 – Ongoing
- Fire Management Plan, 2012 – Public review complete; final consultation in progress
- Invasive Exotic Plant Management Plan and EA, 2003 – Ongoing
- A Strategy for Accelerated Watershed/Vegetation Restoration on the Arapaho and Roosevelt National Forests and Pawnee National Grassland, 2004 – Ongoing

- Forest Health and Fuel Reduction Project – Arapaho National Recreation Area, 2004 – Ongoing
- Fire Management Plan, 2004 – Ongoing
- Bark Beetle Management Plan, 2005 – Ongoing
- Transportation Management Plan/EA – Future
- Emergency Operations Center – Future
- Reroute of the Continental Divide National Scenic Trail – Future
- Greenback Cutthroat Trout Management Plan – Future
- Colorado River Cutthroat Trout Management Plan – Future
- Lynx Conservation Agreement and Strategy, 2002 – Ongoing
- Arapaho and Roosevelt National Forests and Pawnee National Grassland Revised Land and Resource Management Plan, 1997 – Ongoing
- Grand Ditch operations

In addition to specific agency actions and programs, other activities would continue within the park and on lands adjacent to the park or in the region that would cumulatively impact resources. Activities associated with management of the park (building construction, resource management and monitoring, and transportation management) also contribute to adverse impacts on resources from loss of habitat, nonpoint source discharges of sediment and nutrients into waterways, and noise emissions.

WILDERNESS CHARACTER

REGULATIONS, GUIDANCE, AND POLICIES

Wilderness Act

The Wilderness Act, passed on September 3, 1964, established a national wilderness preservation system, "administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness" (16 USC Section 1131). The Wilderness Act further defined wilderness as "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, and which is protected and managed to preserve its natural conditions" (16 USC Section 1131). The Wilderness Act gives the agency managing the wilderness responsibility for preserving the wilderness character of the area and devoting the area to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use (16 USC Section 1133). Certain uses are specifically prohibited, except for areas where these uses have already become established. The act states that "there shall be no commercial enterprise and no permanent road within any wilderness area designated by this chapter and except as necessary to meet minimum requirements for the administration of the area. . . ., there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area" (16 USC Section 1133).

National Park Service Management Policies

The fundamental mission of the national park system is to conserve park natural and historic resources and to provide for the enjoyment of park resources only to the extent that the resources will be left unimpaired for the enjoyment of future generations. As described in section 1.4.6 of *Management Polices* (NPS 2006a), wilderness is recognized and valued as a park resource in keeping with the National Park Service mission.

Management Policies states that "the National Park Service will take no action that would diminish the wilderness suitability of an area possessing wilderness characteristics until the legislative process of wilderness designation has been completed. . .All management decisions affecting wilderness will further apply the concepts of "minimum requirements" for the administration of the area regardless of wilderness category" (NPS 2006a).

Director's Order #41: Wilderness Stewardship

Director's Order #41: Wilderness Stewardship was developed to provide accountability, consistency, and continuity to National Park Service wilderness management efforts and to otherwise guide National Park Service efforts in meeting the requirements set forth by the Wilderness Act of 1964. Director's Order #41 interprets the Wilderness Act and consolidates its requirements and all applicable *Management Policies* to set guiding principles for all National Park Service units to determine wilderness suitability and appropriately manage those lands. Director's Order #41 sets forth guidance for applying the minimum requirements concept to protect wilderness and for the overall management, interpretation, and uses of wilderness. With regards to natural resource management in wilderness, the associated reference manual states, "Management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and the influences originating outside of wilderness boundaries" (NPS 2011a).

Omnibus Public Land Management Act

The Omnibus Public Land Management Act of 2009, passed on March 30, 2009, "designated as wilderness and as a component of the National Wilderness Preservation System approximately 249,339 acres of land in" Rocky Mountain National Park, including the previously proposed project area in the Never Summer Range. The act calls for the exclusion of "(1) The Grand River Ditch (including the main canal of the Grand River Ditch and a branch of the main canal known as the Specimen Ditch), the right-of-way for the Grand River Ditch, land 200 feet on each side of the center line of the Grand River Ditch, and any associated appurtenances, structures, buildings, camps, and work sites in existence as of June 1, 1998" (16 USC Section 1952).

A Conditional Waiver of Strict Liability (16 USC Section 1953) states that, "During any period in which the Water Supply and Storage Company (or any successor in interest to the company with respect to the Grand River Ditch) operates and maintains the portion of the Grand River Ditch in the Park in compliance with an operations and maintenance agreement between the Water Supply and Storage Company and the National Park Service, the provisions of paragraph (6) of the stipulation approved June 28, 1907—(1) shall be suspended; and (2) shall not be enforceable against the Company (or any successor in interest). (b) AGREEMENT.—The agreement referred to in subsection (a) shall—(1) ensure that—(A) Park resources are managed in accordance with the laws generally applicable to the Park, including—(i) the Act of January 26, 1915 (16 USC 191 et seq.); and (ii) the National Park Service Organic Act (16 USC 1 et seq.); (B) Park land outside the right-of-way corridor remains unimpaired consistent with the National Park Service management policies in effect as of the date of enactment of this Act; and (C) any use of Park land outside the right-of-way corridor (as of the date of enactment of this Act) shall be permitted only on a temporary basis, subject to such terms and conditions as the Secretary determines to be necessary; and (2) include stipulations with respect to—(A) flow monitoring and early warning measures; (B) annual and periodic inspections; (C) an annual maintenance plan; (D) measures to identify on an annual basis capital improvement needs; and (E) the development of plans to address the needs identified under subparagraph (D). (c) LIMITATION.—Nothing in this section limits or otherwise affects—(1) the liability of any individual or entity for damages to, loss of, or injury to any resource within the Park resulting from any cause or event that occurred before the date of enactment of this Act; or (2) Public Law 101–337 (16 USC 19jj et seq.), including the defenses available under that Act for damage caused—(A) solely by—(i) an act of God; (ii) an act of war; or (iii) an act or omission of a third party (other than an employee or agent); or (B) by an activity authorized by Federal or State law."

Backcountry and Wilderness Management Plan and Environmental Assessment

Rocky Mountain National Park developed a backcountry and wilderness management plan in 2001 to define wilderness management policies and actions at the park; to have a method of identifying the park's wilderness vision, long range management goals, intermediate objectives, and actions and options to meet those objectives; and to serve as a working guide for staff who manage the wilderness resource. This plan include standards for using motorized equipment and mechanical transport in non-emergency actions, which are in part based on season of year, day of week, and time of day.

National Wilderness Steering Committee, Guidance White Paper Number 2

National Park System lands that have been designated or are managed as wilderness may nonetheless be anthropogenically altered systems. These wilderness lands may benefit from restoration activities, sometimes leading to more fully functioning natural systems and enhanced wilderness character. However, both short-term restoration efforts and long-term conservation activities can negatively affect wilderness character and conflict with the directive of the Wilderness Act that those lands be “untrammeled.” The National Wilderness Steering Committee, *Guidance White Paper Number 2, What Constitutes Appropriate Conservation and Restoration Activities in Wilderness*, provides guidance on a way to evaluate the appropriateness of restoration activities in wilderness. Hydrological and ecological restoration would be classified as a ‘Class I’ activity that entails one-time reversals of anthropogenic changes that, once accomplished are self-sustaining. Users of wilderness might well encounter restoration activities that would typically result in impacts on wilderness character lasting a season to perhaps several years. Implementation of the restoration may include temporary markers or tags and may require the use of heavy equipment. “Upon completion, however, traces of the restoration activity would be extinguished over a short period of time, while the benefits of “re-wilding” and naturalness to wilderness character would be long-term” (National Wilderness Steering Committee 2004).

METHODS AND ASSUMPTIONS FOR ANALYZING IMPACTS

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on wilderness includes the designated wilderness that occurs within (including zones 1B through 4) and adjacent to the restoration area within the Kawuneeche Valley. Cumulative effects that would occur both inside and outside these areas were evaluated using the methods described in the “Cumulative” section.

Issues

Issues that were raised during internal and public scoping regarding restoration activity effects on wilderness included the following:

- Using mechanical equipment to implement restoration activities could affect wilderness and wilderness values.
- The use of temporary browsing exclosure fences could adversely affect the character of wilderness.
- The impact of the 2003 breach has affected wilderness character.
- The ecological and hydrologic conditions that comprise wilderness have been degraded.
- High levels of sedimentation continue to alter areas within wilderness.
- The vegetative species composition found in the wilderness area has changed as a result of the breach.

Assumptions

For the evaluation of impacts on wilderness, it was assumed that most visitors would access the wilderness areas of the northern Kawuneeche Valley from the Colorado River Trail, beginning at the trailhead approximately 3 miles south of the restoration area. The Colorado River Trail includes multiple forks and follows a route adjacent to and within a portion of the restoration area. While the wilderness areas of the Kawuneeche Valley can be accessed from the north off of La Poudre and Thunder Passes and from the south off of the Grand Ditch Trail, these routes are significantly longer and are accessed from remote locations outside of the park.

Assessment Methods

As directed by Director's Order # 41, lands designated as wilderness must be managed to preserve their wilderness character and values.

The technique used to assess wilderness from management activities in this document is in accordance with *Management Policies* (NPS 2006a) and *Director's Order #41: Wilderness Stewardship* (NPS 2011a). The evaluation method considered the four qualities identified in the Definition of Wilderness Section 2(c) from the Wilderness Act of 1964, untrammeled, natural, undeveloped, and opportunities for solitude or primitive and unconfined recreation. These all interact to determine the degree of impact for an activity.

Untrammeled: "an area where the earth and its community of life are untrammeled by man." This means that wilderness is essentially unhindered and free from modern human control or manipulation. Actions that intentionally manipulate or control ecological systems inside wilderness degrade the untrammeled quality of wilderness character, even though they may be taken to restore natural conditions. While the breach was not "intentional," it was a manipulation that confines, limits, restricts, or restrains (also part of the dictionary definition of untrammeled) ecological integrity.

Undeveloped: "an area of undeveloped Federal land retaining its primeval character and influence without permanent improvements or human habitation…" This refers to areas that are essentially without permanent structures, enhancements, or modern human occupation. To retain its primitive character, a wilderness ideally is managed without the use of motorized equipment or mechanical transport.

Natural: "protected and managed so as to preserve its natural conditions…" This means areas that are largely free from effects of modern civilization. It also refers to maintenance of natural ecological relationships and processes, continued existence of native wildlife and plants in largely natural conditions, and absence of distractions (for example, large groups of people; mechanization; and evidence of human manipulation, unnatural noises, signs, and other modern artifacts).

Solitude or Primitive and Unconfined Recreation: "has outstanding opportunities for solitude or a primitive and unconfined type of recreation…" Solitude means encountering few, if any, people, and experiencing privacy and isolation. Primitive and unconfined recreation refers to freedom to explore with few restrictions, and the ability to be spontaneous. It means self sufficiency without support facilities or motorized transportation, and experiencing weather, terrain, and other aspects of the natural world with minimal shelter or assistance from devices of modern civilization.

Steps for assessing impacts included determining the potential impacts on wilderness caused by actions under each alternative. These analyses of impacts on wilderness are qualitative and are assessed given the degree to which restoration and implementation would change conditions compared to the existing.

The other plans and projects whose effects could cumulatively combine with the effects of the Grand Ditch breach restoration alternatives were presented in chapter 1. Only plans and projects that would have effects on wilderness character within the Kawuneeche Valley are considered in the assessment of cumulative effects on wilderness character. The cumulative effects analyses for each of the alternatives evaluates the effects of the other plans and projects on a particular resource, adds the effects identified by the specific restoration action alternative, and then identifies the total cumulative effect, including the degree that the restoration alternative contributes to the overall cumulative effect.

Minimum Requirement Analysis

The implementation of some restoration actions associated with the action alternatives would require a minimum requirement analysis. The rationale for the use of helicopters, earth moving vehicles, mechanized equipment, temporary browsing exclosure fences, and other motorized tools in and over wilderness is included in the attached minimum requirement decision guide (see appendix F). The primary reasons for using motorized tools are to afford effective access, ensure worker safety, and complete the project quickly to reduce further sedimentation and to restore hydrologic integrity in order to minimize further effects from the breach.

Impact Threshold Definitions

Negligible: Changes in the wilderness character and associated values would not be measurable.

Minor: Changes to the wilderness character and associated values would be slightly detectable.

Moderate: Changes to the wilderness character and associated values would be readily apparent.

Major: Changes to the wilderness character and associated values would be substantial and may have permanent consequences.

Beneficial impacts would result in improvements to wilderness character and associated values toward reference conditions.

Adverse impacts would degrade wilderness character and associated values.

Short-term: Effects would cease within one year following cessation of the implementation action.

Long-term: Effects would extend more than a year beyond implementation of a restoration action.

IMPACTS OF ALTERNATIVE A – NO ACTION / CONTINUE CURRENT MANAGEMENT

Analysis

Under the no-action alternative, nearly 250,000 acres of Rocky Mountain National Park, including zones 1B through 4 of the project area would continue to be managed as wilderness in accordance with the backcountry management plan. Zone 1A would remain outside of the wilderness boundary.

Untrammeled. Under the no action alternative, damages caused by the 2003 Grand Ditch breach, as a result of human manipulation of ecological systems, would continue to adversely impact the untrammeled wilderness quality in the Kawuneeche Valley.

The following condition(s) within each zone would continue to impact the untrammeled quality of wilderness:

- The steep gully created from the 2003 breach in zone 1A and 1B is unlikely to fill in naturally and will leave a scar degrading the untrammeled nature of the wilderness;
- Unstable soil in zones 1A and 1B, the large volume of debris within the main Lulu Creek, stream channel and the alluvial fan in zone 2 would continue to erode and degrade the wilderness character by evidencing human caused manipulation;
- Smaller debris deposits along the Colorado River in zone 3 would continue to erode as sediment and affect hydrologic processes and alter the wilderness character; and
- Sediment in zone 4 that is up to 3 feet thick would continue to restrict the Colorado River to the western side of the wetland at an elevated ground surface relative to the summer water

table. The untrammeled quality of the wilderness would be impacted by the human caused degradation evidenced in homogenous vegetation and sheetflow conditions present in the wetland that are different from the conditions that would be found without the influence of the breach.

Alternative A would not alter current conditions or the management of the area. In zones 1B through 4, some stabilization has occurred naturally since 2003. However, full recovery of forested habitat and community functions throughout the project area would take up to 200 years. Natural recovery of the project area would continue slowly with some damages remaining permanent. These continued damages would have long-term adverse impacts of moderate to major intensity on the untrammeled quality of wilderness.

Undeveloped. Under the no action alternative, the park would continue current management of the project area consistent with the park's backcountry management plan prohibiting permanent improvements. No permanent structures or enhancements would be present in wilderness as a result of the breach, and there would be no impact on the undeveloped quality of wilderness.

Natural. Under the no action alternative, damages to the ecological and hydrologic relationships and processes resulting from the 2003 Grand Ditch breach would continue to impact the natural wilderness quality by resulting in conditions that would not otherwise exist.

The following condition(s) within each zone would continue to impact the natural quality of wilderness in that the natural ecological relationships and processes that had existed prior to the breach would be interrupted or permanently altered:

- The loss of upland forest in zone 1B would take 200 to 350 years to recover naturally and would continue to degrade the natural quality of the wilderness due to the resulting loss of habitat and changed vegetation. The steep and unstable gully created by the 2003 breach in zones 1A and 1B is unlikely to fill in naturally and would continue to degrade the natural quality of wilderness by contributing to erosion and downstream sedimentation that impact hydrologic and ecologic processes;
- Erosion and impacts on natural hydrologic processes from loss of upland vegetation, altered land forms, and large volumes of debris deposited within the main stream channel and alluvial fan within zone 2 would continue to degrade the natural quality of the wilderness by altering habitat and water quality within Lulu Creek and further downstream in the Colorado River;
- Erosion and vegetation loss resulting from debris deposits, reworking of sediment deposits, and loss of upland vegetation within zone 3 would continue to affect stream and wetland habitats disturbing the wilderness character; and
- Impacts on natural hydrologic process would continue from sediment deposits up to 20 inches thick that confine the Colorado River to the western side of the wetland and create unnatural sheetflow conditions in zone 4. These conditions degrade the natural quality of the wilderness by elevating the ground surface relative to the summer water table and thereby enabling an altered vegetative community dominated by sedge species.

Alternative A would not alter current conditions or the management of the area. While some natural recovery would continue slowly, full recovery of forested habitat and community functions throughout the project area would take 200 to 350 years, with some damages remaining permanent. Collectively, these conditions would continue to contribute long-term adverse impacts of moderate to major intensity to the natural quality of the wilderness area.

Opportunities for solitude or primitive and unconfined recreation. Under the no action alternative, access in the wilderness within the project area would continue to be limited to foot and horse use. Recreational developments within the wilderness area would continue to include marked trails, pit toilets, backcountry campsites, and signs within the class 3 wilderness corridors. Access and use of these developments would continue to enhance opportunities for unconfined recreation resulting in localized, long-term, and beneficial effects on the wilderness character.

The effects of the 2003 Grand Ditch breach would continue to be present and highly visible from many locations within the wilderness. Impacts on the untrammeled and natural wilderness qualities would continue to degrade the primitive and unconfined aesthetics of solitude resulting in long-term, localized, moderate to major, and adverse impacts on opportunities for primitive recreation.

Cumulative Impacts

The area that was considered for cumulative impacts was designated and eligible wilderness within and adjacent to the project area in Rocky Mountain National Park.

Past, current, and reasonably foreseeable actions that have impacted wilderness character include sights and sounds of human activity, air pollution, inholdings, spread of invasive and exotic species, and resource management.

The Park Omnibus Appropriations Act of 1998 banned the use of low-flying commercial air tours over the park, which had a long-term, regional, beneficial effect on wilderness through the reduction in noise and visual effects on solitude found in wilderness. In 1996, the Thompson Three arrival route to Denver International Airport caused 30 to 70 daily low-flying jets (as close as 15,400 feet in the air) to fly over portions of Rocky Mountain National Park's wilderness, an ongoing short-term, regional, moderate to major, adverse effect on the natural and the solitude or primitive qualities of wilderness, due to the frequency of occurrence.

The presence and operation of the Grand Ditch through the Kawuneeche Valley would continue to impact the wilderness character of the area. Although the ditch is within a right-of-way and is not within the wilderness boundary, the 15 mile ditch is visible from the majority of the wilderness area in the Kawuneeche Valley within Rocky Mountain National Park. Visibility of the ditch and previous unnatural debris flows has a long-term adverse impact of moderate to major intensity to the natural and primitive and unconfined qualities of wilderness character. Streams and creeks that flow from snow runoff on the eastern side of the peaks of the Never Summer Mountains are diverted into the ditch, which flows over the Continental Divide at La Poudre Pass and delivers the water into the Cache La Poudre River. The ditch catches the flow of 12 headwater tributaries and diverts between 20 to 40% of the summer runoff from the Never Summer Mountains. This diversion substantially impacts the ecology in the Kawuneeche Valley below resulting in long-term, major, and adverse impacts on the natural quality of wilderness.

As discussed in the cultural resource section, there are historic remnant structures in the Lulu City area. Although this development is within the wilderness area, given their historic context, these developments would continue to enhance the wilderness character, resulting in localized, long-term, minor to moderate, beneficial effects on the wilderness character.

The spread of invasive exotic species in the region threatens natural resources and ecosystems. Over 100 species of exotic herbaceous plants and grasses occur in Rocky Mountain National Park and the region, including numerous species within wilderness. Non-native species may be inadvertently introduced to wilderness areas by visitors, intermittent automobile use on the ditch road in the project area, and by other species. Controlling exotic vegetation in the wilderness would cause short-term, minor, adverse effects on the natural and untrammeled qualities of wilderness through adversely affecting resources, such as soils, water quality, and soundscape in a manner that would be apparent to observant visitors.

Fire and forest management activities, such as mechanical thinning, prescribed burns, and fire suppression, could potentially involve mechanized tool use in wilderness, which would affect the natural, untrammeled, and primitive and unconfined qualities of wilderness. These actions would result in localized, short-term, moderate, adverse effects.

The project area is close to the summer range of the park's elk population. The large numbers of elk in the park have impacted the plant communities, especially biodiversity within aspen and montane riparian willow communities, such as those found within the lower elevations of the project area. The park's elk and vegetation management plan addresses reducing the impacts of elk on vegetation and restoring, to the extent possible, the natural range of variability in the elk population and affected plant communities. Controlling the elk populations in the wilderness would cause short-term, minor, adverse effects on untrammeled quality and opportunities for solitude or primitive and unconfined recreation through adversely affecting resources such as soundscape.

Overall, these natural resource management actions would result in more natural vegetation conditions than currently exist, which would provide a long-term, beneficial effect on the natural quality of wilderness, and a short-term, minor, adverse effect on the untrammeled quality of wilderness.

Management of the existing network of trails and backcountry campsites in and adjacent to the project area would be restricted to small areas that previously had been disturbed. Trail maintenance would use hand tools where necessary to prevent erosion of trails resulting in a long-term, beneficial effect. Noise generated by trail crews would generate short-term, localized, and negligible to moderate impacts on the primitive quality of wilderness. The presence and visitor use of these facilities would continue to contribute localized, negligible to minor adverse effects on the untrammeled and natural qualities of a site from trash or human activity that degrades the naturalness of a locale, particularly in relation to the natural soundscape.

Opportunities for solitude fluctuate with visitor use depending on the seasons and day of the week. Intrusion upon the quality of solitude for visitors in the wilderness portion of the project area may come from impacts on the natural soundscape from other visitors or aircraft (see the natural soundscapes section in chapter 3 for additional information on intrusions to the natural soundscape). The general intrusion of visitors into the wilderness, which can be in large numbers in some areas, would create a long-term, minor to moderate, adverse effect on wilderness character.

The park's *Backcountry / Wilderness Management Plan and Environmental Assessment* benefits the wilderness within the Kawuneeche Valley by establishing long-term management goals for wilderness management within the park. The plan provides direction for management of natural and cultural resources within the context of wilderness and backcountry management policies, with a primary focus on visitor use and impacts on wilderness values and resources and administrative actions to mitigate associated impacts. Implementation of the plan provides a long-term, moderate benefit.

Outside of the park, adjacent and nearby U.S. Forest Service wilderness areas benefit wilderness within the project area by protecting adjacent lands from non-compatible uses. This continuum of wilderness provides a long-term, moderate, beneficial effect on the wilderness character within the vicinity of the project area.

Collectively, the long-term effects on wilderness within and adjacent to the project area caused by past, current, and foreseeable future actions would be moderate and adverse due largely to the continued presence of and effect of the entire Grand Ditch within wilderness.

Alternative A would result in local, long-term, moderate to major adverse impacts on the untrammeled, natural, and opportunities for solitude or primitive and unconfined recreation qualities of wilderness from the injury caused by the breach. The cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. The actions associated with alternative A would have a small contribution to these cumulative impacts on wilderness character within the vicinity of the Kawuneeche Valley.

Conclusion

Throughout the surrounding wilderness area, the following impacts would be associated with alternative A:

- Damages from the 2003 breach would continue to confine, limit, and restrain ecological integrity and would have long-term, moderate to major, adverse impacts on the untrammeled quality of wilderness.
- Under the no action alternative, there would be no impacts on the undeveloped wilderness quality.
- Ecological and hydrologic processes would continue to be altered by the 2003 breach and would result in long-term adverse impacts of moderate to major intensity on the natural quality of wilderness.
- The visual impacts of the 2003 breach would continue and would have long-term, localized, moderate to major adverse impacts on opportunities for solitude or primitive and unconfined recreation in wilderness.

Cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. This alternative's contribution to these effects would be small.

IMPACTS OF ALTERNATIVE B – MINIMAL RESTORATION

Analysis

Untrammeled. While zone 1A does not fall within the wilderness boundary, implementation of option 1 or 2 would be evident from the wilderness area and some activity would occur on the wilderness boundary. Trucks and additional equipment would be mobilized along the Grand Ditch Road which is outside of the wilderness boundary. During implementation of option 1 or 2, the visibility of human manipulation would have a short-term, moderate, and adverse impact on the untrammeled character of the adjacent wilderness. Once installed, stabilization under option 1 or 2 would allow for some revegetation of the slope. However, the stabilized slope would not look significantly different than the surrounding steep and sparsely vegetated slopes which are remnants of construction of the Grand Ditch. As a result, long-term benefits to the untrammeled wilderness character would be negligible.

The following actions and condition(s) within each subsequent zone would impact the untrammeled quality of wilderness:

- Stabilization of steep slopes in zone 1A would reduce erosion of soil and the release of sediment into wilderness and reduce evidence of human-caused manipulation.
- Some revegetation would occur within zone 1B that would reduce the potential for erosion in localized areas, however, the steep gully in zone 1B would remain and would continue to degrade the untrammeled nature of the wilderness.

- In zone 2, revegetation would occur in spot locations and small boulders would be placed by hand to stabilize the channelbanks in areas. These would reduce the potential for erosion of debris in localized areas. However, the large volume of sediment within the main stream channel and the alluvial fan would remain and would continue to erode and disturb the wilderness character by evidencing human caused degradation.
- In zone 3, areas outside of the active channel would be revegetated and reduce the potential for erosion of debris in localized areas, but sediment deposits in zone 3 would continue to erode and affect hydrologic processes disturbing the wilderness character.
- In zone 4, bare areas would be revegetated with wetland turf or sedge sprigs and would reduce the potential for erosion of debris in localized areas, but sediment would remain in place and the Colorado River would continue to be restricted to the western side of the wetland. The untrammeled quality of the wilderness would continue to be impacted by the resulting homogenous vegetation and sheetflow conditions present in the wetland.

Because revegetation and stabilization would only occur in spot locations under alternative B, full recovery of the habitat and community functions would still take 200 to 350 years and some damages would remain permanent. Collectively, the long-term impacts on the untrammeled wilderness character from revegetation and stabilization would be negligible and beneficial relative to alternative A. Human manipulation from implementation of these small scale restoration actions would result in short-term, moderate adverse impacts on the untrammeled wilderness character.

Undeveloped. Stabilization of zone 1A under option 1 or 2 would require the use of trucks and additional equipment that would be mobilized along the Grand Ditch Road. Implementation would take place both outside of and along the wilderness boundary. During the stabilization of zone 1A, the presence of equipment and machinery would have a short-term moderate adverse impact on the undeveloped character of the adjacent wilderness.

During restoration implementation fieldwork, a line camp and staging area would be established near Dutch Creek (within zone 3) to temporarily house restoration workers within the wilderness. This line camp would consist of sleeping tents, a kitchen tent, and bathroom facilities that would be removed after restoration activities were complete. Additionally, some mitigation measures, such as silt fences would be installed during restoration implementation fieldwork. Collectively, these temporary developments would result in localized, short-term, adverse impacts of moderate intensity to the undeveloped wilderness character.

Natural. In zone 1A, installation of option 1 or 2 would stabilize the slope and prevent erosion of the gully. During and after implementation, the National Park Service would require the use of mitigation measures to prevent erosion. However, due to the unconsolidated nature of the slope, some erosion and downstream sedimentation would occur until the stabilization was complete. During implementation, the short-term impacts on the natural wilderness character would be negligible to minor and adverse. In the long term, erosion and downstream sedimentation from zone 1A would be reduced, resulting in negligible to minor beneficial impacts because some natural processes would return over a long period of time.

The following actions and condition(s) within each zone would impact the natural ecological relationships and processes that had existed prior to the breach:

- Some revegetation would occur within zone 1B that would reduce the potential for erosion in localized areas, however, the steep gully would continue to erode and contribute to downstream sedimentation and adversely impact natural processes.

- In zone 2, revegetation would occur in spot locations and small boulders would be placed by hand to achieve channelbanks stabilization in areas. These would reduce the potential for erosion of debris in localized areas. However, the large volume of sediment within the main stream channel and the alluvial fan would remain and would continue to adversely affect natural processes in Lulu Creek and the Colorado River.
- In zone 3, areas outside of the active channel would be revegetated which would reduce the potential for erosion of debris in localized areas, but sediment deposits and vegetation loss would continue to adversely affect natural processes.
- In zone 4, bare areas would be revegetated with wetland turf or sedge sprigs which would reduce the potential for erosion of debris in localized areas, but sediment would remain in place and the Colorado River would continue to be restricted to the western side of the wetland. The natural quality of the wilderness would continue to be impacted by the resulting homogenous vegetation and sheetflow conditions present in the wetland.

Because revegetation and stabilization would only occur in spot locations under alternative B, full recovery of the habitat and community functions would still take 200 to 350 years. Hydrologic and ecological processes would continue to be impacted by sediment deposits and erosion. However, there would be localized recovery of vegetation along the banks. Collectively, the long-term impacts on the natural wilderness quality from revegetation and stabilization would be negligible to minor and beneficial relative to alternative A.

During implementation, short-term, adverse impacts of minor to moderate intensity would result, collectively, from the following: preparation of soil for seeding, the presence of erosion control mats, the presence of temporary line camps, disturbance of surface waters during bank stabilization, and the use of mitigating measures.

Opportunities for solitude or primitive and unconfined recreation. In zone 1A, during installation of option 1 or 2, trucks and additional equipment would be mobilized along the Grand Ditch Road outside of the wilderness boundary. Additionally, some heavy equipment would be helicoptered in over the wilderness area at the beginning of the implementation phase and flown out upon completion. During their limited use, the presence and noise of helicopters in the wilderness area would have short-term, moderate to major, and adverse impacts on opportunities for solitude and the primitive wilderness character. During implementation of option 1 or 2, the noise and visual presence of equipment and machinery adjacent to the wilderness boundary would have a short-term, moderate adverse impact on the primitive wilderness character and opportunities for solitude. Once installed, option 1 or 2 would not look significantly different from the surrounding slopes. As a result, the long-term impacts on opportunities for solitude or primitive and unconfined recreation would be negligible and beneficial compared with alternative A.

Intrusions to the quality of solitude would occur from the visual presence of work crews, line camps, and the intrusions of human voices and hand tools to the natural soundscape. These intrusions would result in short-term, moderate to major, and adverse impacts on opportunities for solitude or primitive and unconfined recreation. For more information on intrusions of noise in the project area soundscape, see the natural soundscapes section. While most of the debris from the 2003 breach would remain in place, over the long term revegetation and stabilization along the banks would reduce the visual evidence and continuing impacts of the damages caused by the 2003 breach. The reduced visual impacts would result in negligible to minor beneficial impacts on opportunities for solitude or primitive and unconfined recreation.

Under alternative B, restoration implementation fieldwork would start in the late spring and extend until early fall over the course of two years. This time of year coincides with the highest visitor use of the project area. Restoration activities in zones 1B through 4 would be implemented using hand tools and would therefore not produce as much noise as the machinery in zone 1A. During implementation, workers would be temporarily camped in line camps within wilderness in zone 3.

During implementation, portions of the Colorado River and Thunder Pass Trails and the dispersed backcountry campsites close to the project area may be temporarily closed for a short time. Alternate routes would continue to provide access to the wilderness area within the Kawuneeche Valley. Temporary closure of the trails would result in localized, short-term, adverse impacts of minor intensity to opportunities for primitive and unconfined recreation.

In addition, education and interpretation under alternative B would inform visitors of the ecological and hydrologic impacts from the 2003 breach and improve visitor understanding of the intentions and anticipated results of restoration. This increased understanding of the project area and how each wilderness quality has and would be affected would result in long-term, negligible to minor, beneficial impacts on opportunities for solitude or primitive and unconfined recreation.

Cumulative Impacts

Past, current, and foreseeable future actions that impact wilderness within and in proximity to the wilderness area within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on wilderness would continue to be moderate, long-term, and adverse.

Alternative B would result in short-term, minor to moderate, adverse impacts on the untrammeled, natural, undeveloped, and opportunities for solitude or primitive and unconfined recreation qualities of wilderness while implementation activities are underway. It would also result in long-term, beneficial impacts on the untrammeled, natural, and opportunities for solitude or primitive and unconfined recreation qualities of wilderness as restored reference conditions emerge. The cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. The actions associated with alternative B would have a small contribution to the cumulative impacts on wilderness.

Conclusion

Throughout the surrounding wilderness area, the following impacts would be associated with alternative B:

- Implementation activities to provide limited revegetation and stabilization would have short-term, moderate, adverse impacts on the untrammeled wilderness character. Long-term impacts from limited revegetation and stabilization would be negligible and beneficial relative to alternative A.
- Preparation of soil, the presence of erosion control mats and line camps, disturbance of surface waters during bank stabilization, and the use of mitigating measures during implementation would result in short-term, adverse impacts of minor to moderate intensity on the natural wilderness character. Long-term impacts on the natural wilderness character from limited restoration of ecological reference conditions would be negligible to minor and beneficial relative to alternative A.
- During implementation, temporary developments would result in localized, short-term, and adverse impacts of moderate intensity to the undeveloped wilderness character.
- Implementation activities to stabilize areas in zone 1A would result in short-term, moderate, and adverse impacts on the primitive wilderness character and opportunities for solitude. Long-term impacts would be negligible and beneficial.

- In zones 1B through 4, restoration implementation fieldwork and rerouting of trails would result in localized, short-term, minor to major, adverse impacts on opportunities for solitude or primitive and unconfined recreation. The long-term impacts from restoration would be negligible to minor and beneficial.

Cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. This alternative's contribution to these effects would be small.

IMPACTS OF ALTERNATIVE C – HIGH RESTORATION

Analysis

Untrammeled. Impacts on the untrammeled wilderness quality from installation of option 1 or 2 in zone 1A would be the same as those described under alternative B. Short-term impacts during stabilization would be moderate and adverse on the untrammeled character of the adjacent wilderness. Long-term impacts would be negligible and beneficial.

The following actions and condition(s) within each subsequent zone would impact the untrammeled quality of wilderness:

- In zone 1B, the scars from the 2003 breach would be reduced from recontouring and stabilization of undercut slopes and revegetation. However, the steep gully would remain and would continue to degrade the untrammeled nature of the wilderness.
- In zone 2, the following actions would reduce damages from the 2003 breach and improve the untrammeled wilderness quality:
    - Braided channels created by the 2003 breach debris flows in the alluvial fan and farther upstream would be directed into single channels and the old channels would be filled and stabilized;
    - Bare areas would be revegetated and step pools would be enhanced and/or recreated;
    - Banks would be stabilized through recontouring and placement of boulders and large woody material; and
    - Some debris and sediment would be removed from the alluvial fan and used to create terraces in an area northeast of the fan. However, some sediment within the main stream channel and the alluvial fan would remain and would continue to erode and disturb the wilderness character by evidencing human caused degradation.
- In zone 3, large woody material would be relocated to minimize bank erosion and bare areas outside of the active channel would be revegetated. Portions of the berms would be removed to reestablish the hydrologic connectivity but some sediment deposits would remain and would continue to erode and disturb the wilderness character.
- In zone 4, excavation of debris berms would allow the main channel of the Colorado River to return to the center of the wetland and restore hydrologic conditions suitable for a tall willow complex and increased vegetative diversity. Revegetation of bare areas, filling of the western channel, and placement of boulders in highly erosive areas would collectively restore damages caused by the 2003 breach. Some of the 2003 debris would remain within zone 4 affecting the untrammeled quality of the wilderness.

Implementation of the restoration actions would require phasing, mitigation measures, and the use of heavy machinery. Collectively, the human manipulation from implementation of these large-scale restoration actions would result in short-term, major adverse impacts on the untrammeled wilderness character.

Over the long term, the restoration actions would reduce the damage caused by the 2003 breach. The rate of hydrologic and vegetative recovery would also substantially increase throughout much of the project area, although overall restoration of reference conditions would be less and take longer than in alternatives D and E. Collectively, the long-term impacts on the untrammeled wilderness quality would be moderate to major beneficial relative to alternative A. However, the creation of terraces in zone 2 and 3 to accommodate debris and sediment removed from both the wetland and the alluvial fan would impact areas that were previously undisturbed. These terraces would be developed to resemble glacier-caused terraces that are naturally occurring within the park and would be revegetated. As a result of these actions, their presence would result in short-term, moderate, adverse impacts and long-term, minor, adverse impacts on the untrammeled wilderness character.

Undeveloped. Impacts on the undeveloped wilderness quality from stabilization in zone 1A would be the same as described under alternative B. During the stabilization of zone 1A, the presence of equipment and machinery would have a short-term moderate adverse impact on the undeveloped character of the adjacent wilderness. Under alternative C, mechanized equipment would also be used throughout zones 1B through 4. The presence of this equipment and machinery would have a short-term, moderate, and adverse impact on the undeveloped character of the wilderness.

During restoration implementation fieldwork, a line camp and staging area would be established within zone 3 as described under alternative B. Due to the more extensive restoration activities under alternative C, more workers may be required and the line camp would be sized to accommodate the increase. Mitigation measures, such as silt fences would be installed during implementation of the restoration. Temporary mitigation developments would result in localized, short-term, adverse impacts of moderate intensity to the undeveloped wilderness quality.

Additionally, temporary browsing exclosure fences would be installed around willow planting areas in zone 3 and 4 in order to protect the vegetation from elk and other browsing ungulates. These temporary browsing exclosure fences would remain in place for approximately 15 to 20 years, until plants reached approximately 6 feet in height, at which point they would be able to withstand browsing pressure. While these temporary exclosure fences would be removed from the wilderness area, while in place they would result in localized, long-term, and adverse impacts of moderate intensity to the undeveloped wilderness quality.

Temporary channels or by-pass pipes may be installed to re-route Colorado River flows while work to stabilize weak sections of the channel or to excavate the old river meander was taking place. These channels or pipes would be removed once this activity was complete. During implementation, they would result in short-term localized adverse impacts of moderate intensity to the undeveloped wilderness quality.

Natural. Impacts on the natural wilderness quality from installation of option 1 or 2 in zone 1A would be the same as those described under alternative B. Short-term impacts on the natural wilderness character would be adverse and negligible to minor. Long-term impacts would be negligible and beneficial.

The following actions and condition(s) within each subsequent zone would impact the natural ecological relationships and processes that had existed prior to the breach:

- Revegetation and stabilization of slopes through recontouring would reduce erosion in zone 1B. The steep gully would remain and could continue to contribute to some downstream sedimentation.

- In zone 2, revegetation, reestablishment of a single channel through multiple braided areas, bank stabilization, and removal of debris and sediment would reduce downstream erosion and aggradation, improving water quality, aquatic habitat, and enhancing overall stream conditions both within and downstream of the project area. However, some of the 2003 sediment would remain in the main stream channel and the alluvial fan and would continue to alter habitat and water quality in Lulu Creek and the Colorado River.
- In zone 3, revegetation would reduce erosion and improve ecological conditions. A series of cuts through the sediment deposits along the riverbank would reestablish the hydrologic connectivity to the floodplain. The remaining berms could continue to contribute to downstream sedimentation during high water.
- In zone 4, excavation of debris and sediment berms would allow the active river channel to return to the center of the wetland. Removal of the 2003 debris (or equivalent) would restore hydrologic conditions to support a tall willow complex consistent with natural reference conditions. Planting of willows in bare and newly excavated areas would increase species diversity. Some historical debris and sediment would remain in the wetland and could impact hydrologic conditions.

Collectively, during implementation, short-term, moderate, and adverse impacts on the natural wilderness quality would result from the following:

- Preparation of soil for seeding;
- The presence of erosion control mats;
- The presence of temporary line camps;
- Disturbance of surface waters during bank stabilization;
- Disturbance and sedimentation during excavation and channel reconfiguration of Lulu Creek and the Colorado River;
- The creation of material disposal terraces; and
- The use of mitigating measures.

Over the long term, the rate of hydrologic and vegetative recovery would substantially increase, and ecological and hydrologic processes would improve as a result of restoration activities. This would occur throughout much of the project area, although overall restoration of reference conditions would be less and take longer than in alternatives D and E. Collectively, the long-term impacts on the natural wilderness quality would be moderate to major and beneficial relative to alternative A.

Opportunities for solitude or primitive and unconfined recreation. Impacts from stabilization of zone 1A under option 1 or 2 would be the same as described under alternative B. Short-term impacts would be moderate and adverse. Long-term impacts would be negligible and beneficial.

Intrusions to the quality of solitude would be similar to those described under alternative B. The use of temporary browsing exclosure fences around willow plantings in zones 3 and 4 would add another visual intrusion that would impact the primitive quality of the wilderness. These intrusions would result in short and long-term, moderate to major adverse impacts on opportunities for solitude or primitive and unconfined recreation. Over the long term, restoration actions under alternative C would greatly reduce the visual evidence and continuing impacts from the damage caused by the 2003 breach. The reduced visual impacts would result in long-term, moderate, beneficial impacts on opportunities for solitude or primitive and unconfined recreation. However, the creation of material disposal terraces in areas that were previously undisturbed would result in localized, short-term adverse impacts of moderate intensity until vegetation on the terraces becomes established.

During implementation, portions of the Colorado River and Thunder Pass Trails and the dispersed backcountry campsites would be temporarily closed for a short time. Closures would be phased and alternate routes would continue to provide access to the wilderness area within the Kawuneeche Valley. Closure of the trails and campsites would result in localized, short-term, adverse impacts of moderate to major intensity to opportunities for primitive and unconfined recreation.

Impacts from education and interpretation provided under alternative C would be the same as described under alternative B and would result in long-term, minor, beneficial impacts on opportunities for solitude or primitive and unconfined recreation.

Cumulative Impacts

Past, current, and foreseeable future actions that impact wilderness within and in proximity to the wilderness area within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on wilderness would continue to be moderate, long-term, and adverse.

Alternative C would result in short-term, moderate to major, adverse impacts on the untrammeled, natural, undeveloped, and opportunities for solitude or primitive and unconfined recreation qualities of wilderness while implementation activities are underway. It would also result in long-term, moderate to major, beneficial impacts on the untrammeled and natural qualities, and moderate beneficial impacts on opportunities for solitude or primitive and unconfined recreation qualities of wilderness as restored reference conditions emerge. The cumulative impacts on wilderness, including the impacts of this alternative, would continue to be moderate, long-term, and adverse. However, the actions associated with alternative C would have a long-term, beneficial contribution to the cumulative impacts on wilderness.

Conclusion

Throughout the surrounding wilderness area, the following impacts would be associated with alternative C:

- Implementation of revegetation, bank stabilization, debris and sediment removal, and channel reconfiguration would have short-term, major, adverse impacts on the untrammeled wilderness quality. Over the long term, the rate of hydrologic and vegetative recovery would substantially increase, and ecological and hydrologic processes would improve as a result of restoration activities. This would occur throughout much of the project area, although overall restoration of reference conditions would be less and take longer than in alternatives D and E. Long-term impacts from restoration would be moderate to major and beneficial relative to alternative A. The creation of terraces in zones 2 and 3 would result in short-term, moderate, adverse impacts and long-term, minor, adverse impacts on the untrammeled wilderness quality.
- During implementation, temporary developments would result in localized, short and long-term, adverse impacts of moderate intensity to the undeveloped wilderness character.
- During implementation, restoration components would result in short-term, adverse impacts of moderate intensity on the natural wilderness quality. Over the long term, the rate of hydrologic and vegetative recovery would substantially increase, and ecological and hydrologic processes would improve as a result of restoration activities. This would occur throughout much of the project area, although overall restoration of reference conditions

would be less and take longer than in alternatives D and E. Long-term impacts on the natural wilderness quality would be moderate to major and beneficial relative to alternative A.

- Stabilization and restoration implementation fieldwork and the resulting noise, visual presence, and trail and campsite closures would result in localized, short and long-term, moderate to major, adverse impacts on opportunities for solitude or primitive and unconfined recreation. The long-term impacts from restoration would be moderate and beneficial.

Cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. This alternative's contribution to these effects would be beneficial.

IMPACTS OF ALTERNATIVE D – THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Analysis

Untrammeled. Impacts on the untrammeled wilderness quality from installation of option 1 in zone 1A would be the same as those described under alternative B. Short-term impacts during implementation would be moderate and adverse on the untrammeled character of the adjacent wilderness. Long-term impacts on the untrammeled wilderness character would be negligible and beneficial.

The following actions and condition(s) within each subsequent zone would impact the untrammeled quality of wilderness:

- Revegetation would occur within zone 1B; however, the steep gully would remain and would continue to degrade the untrammeled nature of the wilderness.
- In zone 2, the following actions would reduce the damage from the 2003 breach:
    - The debris within the alluvial fan would be removed and used to create terraces in an area northeast of the fan. A single channel would be restored and stabilized through the fan;
    - Bare areas would be revegetated; and
    - Boulders would be placed along the banks to stabilized erosive areas.
- In zone 3, revegetation in bare areas outside of the active channel would reduce evidence of trammeling. Portions of the debris berms would be removed to reestablish the hydrologic connectivity but some sediment deposits would remain and would continue to erode and disturb the wilderness character.
- In zone 4, excavation of debris and sediment berms to allow the main channel of the Colorado River to return to the old oxbow at the head of the wetland and into the historical central channel would restore hydrologic conditions. Removal of the 2003 (or equivalent) debris from the western side of the wetland, revegetation of bare areas with willows, sedges, and hydric grasses and placement of boulders along the banks would collectively restore damages caused by the 2003 breach.

Implementation of the restoration actions would require phasing, mitigation measures, and the use of heavy machinery. Collectively, human manipulation from implementation of these restoration actions would result in short-term, major adverse impacts on the untrammeled wilderness character.

Over the long term, the restoration actions would reduce the damage caused by the 2003 breach. The rate of hydrologic and vegetative recovery would also substantially increase, primarily in the alluvial fan in zones 2 and 3 and in the wetland in zones 3 and 4. Overall restoration of reference conditions would be greater and take less time than in alternatives C but would be less and take more time than in alternative E. Collectively, the long-term impacts on the untrammeled wilderness quality would be major and beneficial relative to alternative A. However, damages from the 2003 breach would remain in zone 1B and the upper portions of zone 2 and the creation of terraces in zone 2 and 3 to accommodate material removed from both the wetland and the alluvial fan would impact areas that were previously undisturbed. As described under alternative C, these terraces would result in short-term, moderate, and adverse impacts and long-term, minor, and adverse impacts on the untrammeled wilderness character.

Undeveloped. Stabilization of zone 1A under option 1 would require the use of trucks and additional equipment that would be mobilized along the Grand Ditch Road and used within zone 1A. Implementation would take place both outside of and along the wilderness boundary. During the stabilization of zone 1A, the presence of equipment and machinery would have a short-term moderate adverse impact on the undeveloped character of the adjacent wilderness. Under alternative D, mechanized equipment would also be used throughout zones 1B through 4. The presence of this equipment and machinery would have a short-term, moderate, and adverse impact on the undeveloped character of the wilderness.

The adverse effects on the undeveloped wilderness quality as a result of a temporary line camp, staging areas, mitigation measures, temporary browsing exclosure fences, and temporary channels or by-pass pipes would be as described in alternative C. Collectively, these temporary developments would result in localized, short-term and long-term, adverse impacts of moderate intensity to the undeveloped wilderness quality.

Natural. Impacts on the natural wilderness quality from installation of option 1 in zone 1A would be the same as those described under alternative B. Short-term impacts on the natural wilderness character would be adverse and negligible to minor. Long-term impacts would be slight and beneficial.

The following actions and condition(s) within each subsequent zone would impact the natural ecological relationships and processes that had existed prior to the breach:

- Revegetation of slopes would reduce erosion in zone 1B. The steep gully would remain and would continue to contribute to some downstream sedimentation.
- In zone 2, revegetation, bank stabilization through plantings, recontouring, and placement of boulders in spot locations would reduce downstream erosion and enhance stream conditions. The removal of the debris from the alluvial fan and restoration of a single channel would reduce erosion substantially. However, some of the 2003 debris would remain in Lulu Creek upstream from the alluvial fan and would continue to alter habitat and water quality in Lulu Creek and the Colorado River.
- As under alternative C, in zone 3, cuts in the debris berms would reestablish the hydrologic connectivity and revegetation would reduce erosion and increase species diversity. The remaining berms could continue to contribute to downstream sedimentation during high water.
- In zone 4, excavation to restore the oxbow at the mouth of the wetland and the historical central Colorado River channel would improve the hydrologic conditions. Removal of 2003 debris (or equivalent) would restore hydrologic conditions to support a tall willow complex consistent with natural reference conditions. Revegetation of willows in the western portion of the wetland would increase species diversity. Revegetation of sedges and hydric grasses in

the central portion of the wetland would reduce erosion. Some historical debris would remain in the wetland and could impact hydrologic conditions.

Collectively, during implementation, short-term, moderate, and adverse impacts on the natural wilderness quality would result from the same restoration components described under alternative C.

Over the long term, the rate of hydrologic and vegetative recovery would substantially increase, and ecological and hydrologic processes would improve as a result of restoration activities, primarily in the alluvial fan in zones 2 and 3 and in the wetland in zones 3 and 4. Overall restoration of reference conditions would be greater and take less time than in alternatives C but would be less and take more time than in alternative E. Collectively, the long-term impacts on the natural wilderness quality would be major and beneficial relative to alternative A.

Opportunities for solitude or primitive and unconfined recreation. Impacts on opportunities for solitude or primitive and unconfined recreation from installation of option 1 in zone 1A would be the same as those described under alternative B. Short-term impacts would be moderate and adverse. Long-term impacts would be negligible and beneficial.

Intrusions to the quality of solitude would be similar to those described under alternative B and would include the use of temporary browsing exclosure fences in zones 3 and 4. These intrusions would result in short and temporary long-term, moderate to major, and adverse impacts on opportunities for solitude or primitive and unconfined recreation. A reduction in the long-term visual evidence and reduced continuing impacts from damages caused by the 2003 breach would be similar to that described under alternative C. While restoration activities would not be as evident in zone 1B and the upper portions of zone 2 as under alternative C, the removal of the alluvial fan and debris and sediment removal and establishment of tall willows in the Lulu City wetland would, in total, greatly reduce the evidence of the 2003 breach. The reduced visual impacts would result in moderate, long-term, beneficial impacts on opportunities for solitude or primitive and unconfined recreation. However, as under alternative C, until they became fully revegetated, the creation of terraces in areas that were previously undisturbed would result in localized, short-term, adverse impacts of moderate intensity.

As under alternative B and C, restoration implementation fieldwork would start in the late spring and extend until early fall over the course of two years. Under alternative D, the use of mechanized equipment and helicopters would be similar to that described under alternative C. Additionally, the removal of temporary browsing exclosure fences would be the same as described under alternative C, 15 to 20 years following restoration implementation fieldwork. The visual presence and noise of mechanized equipment in and adjacent to the wilderness area would have localized short-term, major, and adverse impacts on opportunities for solitude and the primitive wilderness character. For more information on intrusions of noise in the project area soundscape, see the natural soundscapes section.

Temporary closures of dispersed backcountry campsites and portions of the Colorado River and Thunder Pass Trails would be similar to those described under alternative C. Closure of the trails and campsites would result in localized, short-term, adverse impacts of moderate to major intensity to opportunities for primitive and unconfined recreation.

Impacts from education and interpretation provided under alternative D would be the same as described under alternative B and would result in short and long-term beneficial impacts on opportunities for solitude or primitive and unconfined recreation.

Cumulative Impacts

Past, current, and foreseeable future actions that impact wilderness within and in proximity to the wilderness area within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on wilderness would continue to be moderate, long-term, Alternative D would result in short-term, moderate to major, adverse impacts on the untrammeled, natural, undeveloped, and opportunities for solitude or primitive and unconfined recreation qualities of wilderness while implementation activities are underway. It would also result in long-term, major, beneficial impacts on the untrammeled and natural qualities, and moderate beneficial impacts on opportunities for solitude or primitive and unconfined recreation qualities of wilderness as restored reference conditions emerge. The cumulative impacts on wilderness, including the impacts of this alternative, would continue to be moderate, long-term, and adverse. However, the actions associated with alternative D would have a long-term, beneficial contribution to the cumulative impacts on wilderness.

Conclusion

Throughout the surrounding wilderness area, the following impacts would be associated with alternative D:

- Implementation of revegetation, bank stabilization, debris removal, and channel reconfiguration would have short-term, major adverse impacts on the untrammeled wilderness quality. Over the long term, the restoration actions would reduce the damage caused by the 2003 breach. The rate of hydrologic and vegetative recovery would also substantially increase, primarily in the alluvial fan in zones 2 and 3 and in the wetland in zones 3 and 4. Overall restoration of reference conditions would be greater and take less time than in alternatives C but would be less and take more time than in alternative E. Long-term impacts from restoration would be major and beneficial relative to alternative A. The creation of terraces in zones 2 and 3 would result in short-term, moderate, adverse impacts and long-term, minor, adverse impacts on the untrammeled wilderness quality.
- During implementation, temporary developments would result in localized, short- and temporary long-term, adverse impacts of moderate intensity to the undeveloped wilderness character.
- During implementation, restoration components would result in short-term, adverse impacts of moderate intensity on the natural wilderness quality. Over the long term, the rate of hydrologic and vegetative recovery would substantially increase, and ecological and hydrologic processes would improve as a result of restoration activities, primarily in the alluvial fan in zones 2 and 3 and in the wetland in zones 3 and 4. Overall restoration of reference conditions would be greater and take less time than in alternatives C but would be less and take more time than in alternative E. Long-term impacts on the natural wilderness quality would be major and beneficial relative to alternative A.
- The resulting noise, visual presence, and trail and campsite closures from restoration implementation fieldwork would result in localized, short- and temporary long-term, moderate to major, adverse impacts on opportunities for solitude or primitive and unconfined recreation. The long-term impacts from restoration would be moderate and beneficial.

Cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. This alternative's contribution to these effects would be beneficial.

IMPACTS OF ALTERNATIVE E – MAXIMUM RESTORATION

Analysis

Untrammeled. Impacts on the untrammeled wilderness quality from installation of option 1 or 2 in zone 1A would be the same as those described under alternative B. Short-term impacts during implementation would be moderate and adverse on the untrammeled character of the adjacent wilderness. Long-term impacts on the untrammeled wilderness character would be negligible and beneficial.

The following actions and condition(s) within each subsequent zone would impact the untrammeled quality of wilderness:

- Filling in the gully to pre-2003 contours and revegetating the area would fully restore the damages caused by the breach in zone 1B.
- In zone 2, the following actions would reduce the damage and potential releases of sediment from the 2003 breach:
    - Braided channels created by the 2003 breach debris flows in the alluvial fan and farther upstream would be directed into single channels and stabilized;
    - Bare areas would be revegetated and step pools would be enhanced and/or recreated;
    - Banks would be stabilized through recontouring and placement of boulders and large woody material; and
    - The debris within the alluvial fan would be removed and used to create terraces in an area northeast of the fan. The alluvial fan and the newly created terraces would be revegetated with upland species.
- In zone 3, relocation of large woody material to minimize bank erosion and enhance step pools and pool-riffle complexes would reduce damages caused by the 2003 breach. Revegetation of riparian and upland species would restore bare areas created by the breach. Removal of the debris berms would reestablish the hydrologic connectivity.
- In zone 4, excavation of berms to allow the main channel of the Colorado River to return to the old oxbow at the head of the wetland and into the historical central channel would restore hydrologic conditions. Removal of the 2003 and all historical debris and sediment from the western side of the wetland and filling of the western channel would create conditions suitable for native tall willow consistent with natural reference conditions. Revegetation of bare areas with willows and placement of boulders along the banks would increase stabilization and reduce erosion. These actions would greatly reduce the damage caused by the 2003 breach.

Implementation of the restoration actions would require phasing, mitigation measures, the use of heavy machinery, and development of a staging/haul road through zone 3. Terraces would be created in previously undisturbed areas in zones 2, 3, and 4. Collectively, the human manipulation from implementation of these restoration actions, the presence of restoration workers, and impacts on previously undisturbed areas would result in short-term, major, and adverse impacts on the untrammeled wilderness character.

Over the long term, the restoration actions under alternative E would greatly reduce erosion and restore damages caused by the 2003 breach. The rate of hydrologic and vegetative recovery would also substantially increase due to the large amount of restoration action in zones 2, 3, and 4. Overall restoration of reference conditions would be the greatest and take the least time of all the alternatives. Collectively, the long-term impacts on the untrammeled wilderness quality would be major and beneficial relative to alternative A. However, the creation of terraces in zones 2, 3, and 4 to accommodate debris and sediment removed from both the wetland and the alluvial fan would impact areas that were previously undisturbed. As described under alternative C, these terraces would result in short-term, moderate, and adverse impacts and long-term, minor, and adverse impacts on the untrammeled wilderness character.

Undeveloped. Impacts on the undeveloped wilderness quality from the presence of equipment and machinery in zones 1A through 4 would be the same as described in alternative C and would be short-term, moderate, and adverse.

Under alternative E, mitigation measures would ensure the protection of the historic Lulu City during restoration implementation fieldwork and impacts from this development would be the same as those described under the no action alternative.

During implementation, a line camp and staging area would be established within zone 3 as described under alternative C. Alternative E could require an additional season to implement and would therefore require prolonged use of the line camps. Mitigation measures, such as silt fences would be installed during implementation of the restoration. The use of temporary browsing exclosure fences and temporary channels or by-pass pipes in zones 3 and 4 would be the same as described under alternative C. Additionally, a temporary staging/haul road would be developed between zones 3 and 4 to move excavated material from zone 4 to storage areas in zone 3. This road would be restored when implementation was complete. Collectively, these temporary developments would result in localized, short and long-term, adverse impacts of moderate intensity to the undeveloped wilderness quality.

Natural. Impacts on the natural wilderness quality from installation of option 1 or 2 in zone 1A would be the same as those described under alternative B. Short-term impacts on the natural wilderness character would be adverse and negligible to minor. Long-term impacts would be negligible and beneficial.

The following actions and condition(s) within each subsequent zone would impact the natural ecological relationships and processes that had existed prior to the breach:

- Filling the gully to pre-2003 contours and revegetating would eliminate erosion from zone 1B.
- In zone 2, revegetation, reestablishment of a single channel through multiple braided areas, bank stabilization, creation and enhancement of step pools, and removal of all of the debris in the alluvial fan would reduce downstream erosion and enhance stream conditions.
- Bank stabilization, revegetation, wetland, and step pool enhancement would reduce downstream sedimentation and improve ecological conditions in the river. Removal of the debris berms on the eastern side of the river would reestablish the hydrologic connectivity and enhance conditions for tall willow. Revegetation of willow would reduce erosion and increase species diversity.
- In zone 4, excavation to restore the oxbow at the mouth of the wetland and the historical central Colorado River channel would improve the hydrologic conditions. Removal of all of the 2003 and historical debris would restore hydrologic conditions to support a tall willow complex consistent with natural reference conditions. Revegetation of willows in the western and central portions of the wetland would increase species diversity and reduce downstream sedimentation. The removal of the historical debris would result in more stable hydrologic conditions.

Collectively, during implementation, short-term, moderate, and adverse impacts on the natural wilderness quality would result from the same restoration components described under alternative C, in addition to the following:

- The development of a temporary staging/haul road; and
- The use of additional debris storage areas.

Over the long term, the rate of hydrologic and vegetative recovery would substantially increase, and ecological and hydrologic processes would be restored due to the large amount of restoration action in zones 2, 3, and 4. Overall restoration of reference conditions would be the greatest and take the least time of all the alternatives. Collectively, the long-term impacts on the natural wilderness quality would be major and beneficial relative to alternative A.

Opportunities for solitude or primitive and unconfined recreation. Impacts on opportunities for solitude or primitive and unconfined recreation from stabilization of zone 1A under option 1 or 2 would be the same as those described under alternative B. Short-term impacts would be moderate and adverse. Long-term impacts would negligible and beneficial.

Intrusions to the quality of solitude would be similar to those described under alternative C and would include the use of temporary browsing exclosure fences in zones 3 and 4. Additionally, the presence of a temporary staging/haul road would occur under alternative E. These intrusions would result in short and long-term, moderate to major, and adverse impacts on opportunities for solitude or primitive and unconfined recreation. A reduction in the long-term visual evidence and reduced continuing impacts from damages caused by the 2003 breach would be similar to that described under alternative C. The removal of the alluvial fan and debris removal and establishment of tall willows in the Lulu City wetland would greatly reduce the evidence of the 2003 breach. The reduced visual impacts would result in moderate, long-term, beneficial impacts on opportunities for solitude or primitive and unconfined recreation. However, as under alternative C, until they became fully revegetated, the creation of debris terraces in areas that were previously undisturbed would result in localized, short-term, adverse impacts of moderate intensity.

As under alternative B, C, and D, restoration implementation fieldwork would start in the late spring and extend until early fall. However, alternative E would take place over the course of two to three years. The use of mechanized equipment and helicopters would be similar to that described under alternative C. However, under alternative E, the use of mechanized equipment would be prolonged due to the increased amount of debris being removed from zone 4. Additionally, the removal of temporary browsing exclosure fences would be the same as described under alternative C, 15 to 20 years following restoration implementation fieldwork. The visual presence and noise of mechanized equipment in and adjacent to the wilderness area would have localized, short-term, major, and adverse impacts on opportunities for solitude and the primitive wilderness character. For more information on intrusions of noise in the project area soundscape, see the Natural Soundscapes section.

Temporary closures of dispersed backcountry campsites and portions of the Colorado River and Thunder Pass Trails would be similar to those described under alternative C. The removal of additional debris in zone 4 and potential for an additional season to complete the restoration would result in prolonged closures of trails and campsites. Closure of the trails and campsites would result in localized, short-term, adverse impacts of moderate to major intensity to opportunities for primitive and unconfined recreation.

Impacts from education and interpretation provided under alternative E would be the same as described under alternative B and would result in long-term, minor, beneficial impacts on opportunities for solitude or primitive and unconfined recreation.

Cumulative Impacts

Past, current, and foreseeable future actions that impact wilderness within and in proximity to the wilderness area within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on wilderness would continue to be moderate, long-term, and adverse.

Alternative E would result in short-term, moderate to major, adverse impacts on the untrammeled, natural, undeveloped, and opportunities for solitude or primitive and unconfined recreation qualities of wilderness while implementation activities are underway. It would also result in long-term, major, beneficial impacts on the untrammeled and natural qualities and in moderate, beneficial impacts on opportunities for solitude or primitive and unconfined recreation qualities of wilderness as restored reference conditions emerge. The cumulative impacts on wilderness, including the impacts of this alternative, would continue to be moderate, long-term, and adverse. However, the actions associated with alternative E would have a long-term, beneficial contribution to the cumulative impacts on wilderness.

Conclusion

Throughout the surrounding wilderness area, the following impacts would be associated with alternative E:

- Implementation of revegetation, bank stabilization, debris removal, and channel reconfiguration would have short-term, major, adverse impacts on the untrammeled wilderness quality. Over the long term, the restoration actions under alternative E would greatly reduce erosion and restore damages caused by the 2003 breach. The rate of hydrologic and vegetative recovery would also substantially increase due to the large amount of restoration action in zones 2, 3, and 4. Overall restoration of reference conditions would be the greatest and take the least time of all the alternatives. Long-term impacts from restoration would be major and beneficial relative to alternative A. The creation of terraces in zones 2, 3, and 4 would result in short-term, moderate, adverse impacts and long-term, minor, adverse impacts on the untrammeled wilderness quality.
- During implementation, temporary developments would result in localized, short and long-term, adverse impacts of moderate intensity to the undeveloped wilderness character.
- Actions and components of restoration during implementation would result in short-term adverse impacts of moderate intensity on the natural wilderness quality. Over the long term, the rate of hydrologic and vegetative recovery would substantially increase, and ecological and hydrologic processes would be restored due to the large amount of restoration action in zones 2, 3, and 4. Overall restoration of reference conditions would be the greatest and take the least time of all the alternatives. Long-term impacts on the natural wilderness quality would be major and beneficial relative to alternative A.
- The resulting noise, visual presence, and trail and campsite closures from restoration implementation fieldwork would result in localized, short- and long-term, moderate to major, adverse impacts on opportunities for solitude or primitive and unconfined recreation. The long-term impacts from restoration would be moderate and beneficial.

Cumulative impacts on wilderness would continue to be moderate, long-term, and adverse. This alternative's contribution to these effects would be beneficial.

NATURAL SOUNDSCAPE

REGULATIONS, GUIDANCE, AND POLICIES

National Park Service Management Policies

The fundamental mission of the national park system is to conserve park natural and historic resources and to provide for the enjoyment of park resources only to the extent that the resources will be left unimpaired for the enjoyment of future generations. As described in Section 1.4.6 of *Management Polices 2006* (NPS 2006a), natural soundscapes are recognized and valued as a park resource in keeping with the NPS mission.

The natural soundscape, sometimes called natural quiet, is the aggregate of all the natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Management goals for soundscapes are included in Section 4.9 of *Management Policies* (NPS 2006a) and in Director's Order #47: Soundscape Preservation and Noise Management (NPS 2000).

Management Policies requires restoration of degraded soundscapes to the natural condition whenever possible and protection of natural soundscapes from degradation.

Director's Order #47: Soundscape Preservation and Noise Management

Director's Order #47: Soundscape Preservation and Noise Management requires, "to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources" (NPS 2000). It also states that "the fundamental principle underlying the establishment of soundscape preservation objectives is the obligation to protect or restore the natural soundscape to the level consistent with park purposes, taking into account other applicable laws" (NPS 2000). Noise is generally considered appropriate if it is generated from activities consistent with park purposes and at levels consistent with those purposes.

The National Park Service is directed to "take action or prevent or minimize all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored" (NPS 2000). Director's Order #47 provides the following policy direction: "Where natural soundscape conditions are currently not impacted by inappropriate noise sources, the objective must be to maintain those conditions. Where the soundscape is found to be degraded, the objective is to facilitate and promote progress toward the restoration of the natural soundscape" (NPS 2000). Where legislation provides for specific noise-making activities in parks, the soundscape management goal would be to reduce the noise to the level consistent with the best technology available, which would mitigate the noise impact but not adversely affect the authorized activity. When a noise-generating activity is consistent with park purposes, "soundscape management goals are to reduce noise to minimum levels consistent with the appropriate service or activity" (NPS 2000).

METHODS AND ASSUMPTIONS FOR ANALYZING IMPACTS

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on natural soundscapes includes the Kawuneeche Valley from the western ridgeline to the eastern ridgeline, including the area impacted by the 2003 Grand

Ditch breach. Cumulative effects that would occur both within and outside of this area were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were raised during internal and public scoping regarding effects from implementing restoration on natural soundscapes included impacts from restoration activities that create noise, such as use of mechanized equipment, use of hand tools, work camps, and helicopter use. Because the majority of the project area is within wilderness, activities associated with the restoration activities would introduce human-caused noise into the soundscape in an undeveloped, sensitive area of the park.

Sound Characteristics

Duration and frequency of occurrence affect the impact that a noise would produce. For example, a loud noise that occurs infrequently and for short time periods may have less of an impact than a quieter noise that occurs over a longer period at frequent intervals.

Examples of common noise levels include a firecracker as 150 dBA and rainfall as 50 dBA (LHH 2003). On average, noise levels decrease 6 dBA for every doubling of distance (Mcsquared System Design Group, no date). For the purposes of this document, noise levels are presented at the source and additionally at 1,000 feet and 1 mile, using this rule to calculate decibel levels at farther distances.

These factors were addressed qualitatively in the impact analysis.

Assumptions

The major assumptions used in the analysis of effects on soundscapes were as follows:

- Based on acoustic data collected in locations within Rocky Mountain National Park with similar acoustic conditions, the natural ambient in the Grand Ditch area is estimated at 33 dBA during the day and 19 dBA at night. NPS Management Policies state that the natural ambient sound level—that is, the environment of sound that exists in the absence of human-caused noise—is the baseline condition and the standard against which current conditions in a soundscape will be measured and evaluated. Sound levels in excess of the ambient noise levels have the potential to affect the soundscape.
- Restoration implementation fieldwork-related noise would occur during daylight hours throughout the week as needed, and no heavy machinery would be used during nighttime hours.
- Noise effects will occur only during restoration activities. The noise effects from restoration activities are expected to have no long-term positive or adverse impacts on the park's soundscape.

Noise levels above ambient levels were assumed to be capable of affecting the terrestrial soundscape within the project area and the Kawuneeche Valley. Effects on the soundscape were evaluated by considering the duration of the noise and the distance required before noise levels attenuate to natural ambient levels.

Assessment Methods

The technique used to assess noise impacts from restoration activities in this document is in accordance with *Management Policies* (NPS 2006a) and *Director's Order #47: Soundscape*

Preservation and Noise Management (NPS 2000). The evaluation method considered the noise levels produced from mechanized equipment likely to be used during restoration activities in terms of the distance required for the sound to attenuate (diminish) to natural ambient levels. The expected duration of the restoration activities for each alternative was also considered. Additional primary references for equipment noise levels include *Transit Noise and Vibration Impact Assessment*, prepared by Harris Miller Miller & Hanson Inc. Known decibel levels of activities were compared against baseline natural sound levels measured by the NPS Natural Sounds and Night Skies Division to determine the effects of the actions on soundscapes. The following analysis can only evaluate sounds on an individual level, and its ability to assess additive impacts on the overall soundscape is limited.

The analysis evaluates only the effects of the alternative actions on the baseline natural soundscape. The effects of all other human-caused noises that occur in or affect the project area are considered in the cumulative impact analysis. As described in the "General Methodology" section, the cumulative impact analysis evaluates the effects of the alternative actions in combination with all other past, present, and future actions (in this section, all other human-caused noise) within the geographic area of analysis.

Primary steps for assessing impacts would include:

- Identifying existing activities or conditions that may be affected by noise from implementing the restoration alternatives;
- Determining the potential noise levels and duration caused by actions under each alternative; and
- Identifying the impacts on the natural soundscape in potential areas where noise concentrations and the effects of sounds may be of concern.

Rocky Mountain National Park resources most likely to be affected by restoration activities include the park's natural soundscape, wilderness areas, and noise-sensitive wildlife. Potential impacts of noise on wildlife and wilderness are presented in those sections of the document. Impacts on visitor experience are presented in the visitor use and experience section. Analysis in this section is intended to disclose impacts on the natural soundscape specifically, recognizing that sound is an intrinsic part of other resources and values in Rocky Mountain National Park.

The other plans and projects whose effects could cumulatively combine with the effects of the Grand Ditch breach restoration alternatives were presented in chapter 1. Only plans and projects that would have effects on natural soundscapes within the general geographic area affected by the breach are considered in the assessment of cumulative effects on natural soundscapes. The cumulative effects analyses for each of the alternatives evaluates the effects of the other plans and projects on a particular resource, adds the effects identified by the specific restoration alternative, and then identifies the total cumulative effect, including the degree that the restoration alternative contributes to the overall cumulative effect.

Impact Threshold Definitions

Negligible: There would be no introduction of artificial noise into the park.

Minor: Noise from the action would rarely be audible (<5% of the day) or would attenuate to natural ambient levels within a short distance (<330 feet) from the source.

Moderate: Noise from the action would occasionally be audible (<10% of the day) or would attenuate to natural ambient levels within an intermediate distance (<0.3 miles) from the source.

Major: Noise from the action would be regularly audible (>10% of the day) or would attenuate to natural ambient levels within a large distance (>0.3 miles) from the source.

Beneficial effects would reduce levels of human-created noise or would increase the prevalence of natural sounds in the soundscape.

Adverse effects would result in higher levels of human-created noise in the soundscape.

Short-term: Periods of human-created noise would occur during restoration implementation fieldwork.

Long-term: Periods of human-caused noise would last longer than restoration implementation fieldwork.

IMPACTS OF ALTERNATIVE A – NO ACTION / CONTINUE CURRENT MANAGEMENT

Analysis

No management actions would occur under alternative A and, therefore, impacts on the natural soundscape would be negligible.

Mechanized Equipment and Hand Tools. Under alternative A, use of mechanized equipment and hand tools would be limited to resource management and emergency situations. Please refer to the 'Cumulative Impacts' section below for additional information regarding NPS operations occurring within the wilderness of the Kawuneeche Valley.

Overnight Camps. Noise levels at night are generally lower than during the day. Under alternative A, overnight use of the wilderness area in the Kawuneeche Valley would require the use of a backcountry permit. Camping would continue to be restricted to designated backcountry campsites and areas during the summer and within the park's designated area in winter. Due to group size limits and minimum half mile distances between campsites, adverse impacts on the natural soundscape from their use would be short term and negligible to minor.

Cumulative Impacts

Recorded noise intrusions within the park vary from 50 to 105 dBA, and include people, jets, and helicopters. In wilderness areas, over the course of one hour, natural sounds could be heard without intrusion from 75% to 95% of the time. These measurements were all taken during daylight hours, from 11 a.m. to 6 p.m. These sound measurements demonstrate that depending on where an area is located in the park, natural sounds and existing noise intrusions vary. Open areas have a lower background soundscape and noise intrusions are therefore more notable (Harris, Miller, Miller, and Hanson 1998).

A number of ongoing activities that involve mechanical operations (exotic vegetation management, bark beetle, and fuels management) have the potential to occur within the wilderness area in the Kawuneeche Valley. These operations would introduce noise from chain saws and other mechanical equipment causing short-term, local, moderate, adverse effects. Other National Park Service actions that may have an impact on the natural soundscape in the Kawuneeche Valley include research activities, search and rescue operations, and trail management activities. With the exception of emergencies, use of all other equipment would comply with a minimum requirement analysis. These activities could include the use of vehicles, helicopters, hand tools, and chain saws and would cause short-term, adverse effects on the soundscape that would range from negligible to major.

Operation and maintenance of the Grand Ditch includes seasonal use of vehicles and equipment along the Grand Ditch Road. Adverse impacts on the natural soundscape from this use would be short-term and negligible to minor in intensity.

The Park Omnibus Appropriations Act of 1998 banned the use of low-flying commercial air tours over the park resulting in a short-term, regional, beneficial effect. However, a dominant additional noise intrusion would continue to occur in areas from 30 to 70 low-level jets (between 19,000 and 15,400 feet, up to 90 dBA at those distances) flying over the park en route to Denver International Airport (NPS 2007c). Changes in flight routes and descent paths for commercial aircraft implemented by FAA in 2012 would increase commercial aircraft noise over the project area but would not change the conclusion of impact intensity. These flights occur on a daily basis resulting in short-term, major, adverse effects on the natural soundscape over portions of the park.

The park's backcountry and wilderness plan provides long-term, regional, moderate, benefits to the natural soundscape by encouraging the limitation of noises into the backcountry, but it is limited to actions on the ground in the park.

Collectively, the effects of these actions would result in continued short-term, local and regional, moderate, adverse effects on soundscapes. While effects from the air tour ban are beneficial, the introduction of other noise intrusions into the soundscape would still contribute short-term, moderate, adverse effects.

Alternative A would result in negligible to minor adverse impacts. The cumulative effects on the natural soundscape would continue to be short term, local and regional, moderate, and adverse. The actions associated with alternative A would have a small contribution to these cumulative impacts on soundscape within the vicinity of the Kawuneeche Valley.

Conclusion

Under the no action alternative, no restoration management actions would occur and therefore impacts on the natural soundscape would be negligible. Impacts on the natural soundscape from the permitted use of backcountry campsites would be short-term and negligible to minor and adverse depending on the time on the time of year and location.

The cumulative effects on the natural soundscape would continue to be short term, local and regional, moderate, and adverse. The actions associated with alternative A would have a small contribution to the cumulative impacts on natural soundscape.

IMPACTS OF ALTERNATIVE B – MINIMAL RESTORATION

Analysis

Mechanized Equipment and Hand Tools. In zone 1A, installation of option 1 or 2 would require the use of heavy machinery. Some of this machinery, in addition to materials for line camps, would be flown in and out of the project area by helicopter at the start and end of restoration activities. During working hours, heavy equipment and restoration activities would generate noise in the project area for up to five months each year for two years. Each facet of the implementation would incorporate different equipment and methods which all emit noise at different frequencies and durations. Machinery required for stabilization implementation in zone 1A would include the following: a loader, an air compressor, a 16-cubic-yard truck to be driven along the Ditch Road, and an excavator. This machinery could be used both in zone 1A and along portions of the Grand Ditch Road, within zone 1A and/or north of the project area.

Table 4.1 identifies anticipated mechanized equipment requirements for this project and the distance at which noise emissions will attenuate to natural ambient conditions.

Table 4.1: Noise Attenuation of Mechanized Equipment

Equipment	Sound Level	Approximate Distance at Which Noise Attenuates to Natural Ambient
Generator	77 dBA	0.3 miles day; 1.4 miles night
Hammer, cordless drill	65 dBA	0.07 miles
Air compressor	81 dBA @ 50'	1.4 miles
Backhoe/excavator	80 dBA @ 50'	2 miles
Menzi Muck A91	101 dBA LWA	1.6 miles
Dozer	85 dBA @ 50'	3.2 miles
Jack hammer	88 dBA @ 50'	4.25 miles
Loader	85 dBA @ 50'	3.2 miles
Helicopter	87 dBA @ 50’	4 miles
Chain saw	83 dBA @ 50’	2 miles
Loader and backhoe operating together	86 dBA @ 50’	4 miles

During working hours, use of mechanized equipment in zone 1A would create intrusions to the natural soundscape. As shown in table 4.1, noise from impacts would attenuate to natural ambient levels at distances ranging from 385 feet for the cordless drill/hammer to more than 4 miles for the jackhammer. When multiple pieces of machinery operate simultaneously, the attenuation distance increases. For example, noise from the loader diminishes to natural ambient at a distance of 3 miles and the backhoe at a distance of 2 miles. When operated together, the combined noise attenuates to natural ambient at a distance of 4 miles. Use of this equipment would result in short-term, major, adverse effects on the natural soundscape, depending on distance from the source.

Effects on the natural soundscape from use of the helicopter (91–93 dBA, depending on type, at 200 feet directly overhead and audible from more than one mile away) would be short-term, local and regional, negligible to major, and adverse, depending on the distance from the helicopter. The duration would be brief point to point flights.

In zones 1B through 4, restoration activities including revegetation and stabilization would be implemented with hand tools. Restoration activities would occur seasonally over the course of two years. Tools to be used could include the following: chain saws, hammers, winches, pumjars, and come-alongs. Although the chain saw would be used infrequently, its use (83 dBA at 50 feet, approximately 58 dBA at 1,000 feet, and approximately 49 dBA at half a mile) would have the largest impact on the natural soundscape. Impacts on the natural soundscape from the use of chainsaws would be infrequent, short-term, moderate, and adverse. During the working day, other noise intrusions would come from the use of hand tools and conversations/commands between workers to implement minor recontouring, revegetation, and movement of boulders to stabilize erosion prone banks. Use of hand tools would vary each day and within each zone. Within zones 1B and 2, the ambient noise levels are likely somewhat higher along Lulu Creek and the Colorado River. Therefore, during times when no mechanized equipment is operating in Zone 1A, impacts on the natural soundscape within zones 1B and 2 would be more localized, short-term, minor, and adverse. Within zones 3 and 4, ambient noise levels would be lower. Therefore, during times when no mechanized equipment is operating in Zone 1A, impacts on the natural soundscape within zones 3 and 4 would be more localized, short term, minor to moderate, and adverse depending on the tools and restoration activity.

Resource protection measures to minimize impacts on the natural soundscape could include standard noise abatement mitigation measures such as the following:

- Use equipment with the lowest possible noise emissions.
- Follow schedule that minimizes impacts on adjacent noise-sensitive areas and during acoustically sensitive times of day (dawn/dusk).
- Use hydraulically or electrically powered impact tools and chainsaws when feasible.
- When possible, shut off equipment rather than allowing it to idle when not in operation
- Minimize use of air compressors, backhoes, dozers, jackhammers, and loaders.
- Where possible, use high-efficiency mufflers.

All restoration equipment would be kept in proper operating condition, and the location of stationary, noise emitting equipment would be strategically placed and covered with a noise-dampening enclosure when possible to reduce noise emissions.

Overnight Camps. Under alternative B, line camps would be temporarily established along the ditch road and near Dutch Creek in zone 3 to house workers during the summer work season. Noise generated within these camps would include the emergency nighttime use of generators (77 dBA at the source) and human conversation (60 dBA at the source). Activity in the line camps would be highest around meal times before and after the work day with very little activity occurring overnight. Due to the location of these line camps in areas with lower ambient sound levels, and because ambient noise levels are lower at night than during the day, noise generated when these camps are occupied would have short-term, adverse impacts of major intensity on the natural soundscape. Impacts from nighttime emergency use of generators would be mitigated by using the latest guidance provided by the NPS Acoustical Toolbox (NPS 2010d), which recommends covering generators with noise-dampening enclosures, running the generators as little as possible, and limiting use of generators during acoustically sensitive periods (dawn and dusk).

During implementation of restoration activities there could be temporary closures to the backcountry dispersed campsites that are located in close proximity to Lulu Creek and the Colorado River. Temporary closure of these sites would reduce the number of overnight visitors in the area and therefore reduce human-caused noise at night. However, due to the location of these campsites, the low levels of use and noise typically associated with these wilderness campsites, and the addition of two line camps, beneficial impacts from this closure would be slight.

Cumulative Impacts

Past, current, and foreseeable future actions that impact the natural soundscape within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on the natural soundscape would continue to be short-term, local and regional, moderate, and adverse.

Alternative B would result, overall, in short-term, major adverse impacts on the natural soundscape. The cumulative effects on the natural soundscape would continue to be short term, local and regional, major, and adverse. The actions associated with alternative B would make a modest contribution to the cumulative impacts on the natural soundscape.

Conclusion

Under alternative B, impacts from the use of heavy machinery to implement option 1 or 2 in zone 1A would be short term, major, and adverse. Effects on the natural soundscape from the use of a helicopter to fly machinery and supplies in and out of the project area at the start and end of restoration activities would be short-term, major, and adverse. The sounds emitted by equipment would be audible frequently throughout the day up to 4 miles from the source.

When no equipment is operating in zone 1A, the use of hand tools in zones 1B and 2, where the ambient noise level is higher, would result in localized, short-term, minor, adverse impacts. Within zones 3 and 4, where the ambient noise levels are lower, adverse impacts on the natural soundscape would be localized, short-term, and minor to moderate depending on the tools and restoration activity. The sounds emitted by hand tools or chainsaws would be audible either occasionally, as with chainsaws, or less than 0.3 miles from the source, as with hand tools.

Emergency nighttime use of a generator in both temporary line camps established in the project area would have short-term, adverse impacts of major intensity on the natural soundscape because noise would be audible up to 1.4 miles during sensitive times of the day. Temporary closure of the backcountry campsites would result in a negligible beneficial impact on the natural soundscape.

The cumulative effects on the natural soundscape would continue to be short term, local and regional, major, and adverse. The actions associated with alternative B would make a modest contribution to the cumulative impacts on natural soundscape.

IMPACTS OF ALTERNATIVE C – HIGH RESTORATION

Analysis

Mechanized Equipment and Hand Tools. Installation of option 1 or 2 in zone 1A would utilize the same equipment as described under alternative B. However, under alternative C restoration activities in zones 1B through 4 would also utilize heavy machinery. The combined use of heavy machinery in all zones would increase noise levels across the project area. As under alternative B, restoration activities would take place during working hours for up to five months each year for two years.

During working hours, use of mechanized equipment in zone 1A and north of zone 1A along the Grand Ditch Road would create intrusions to the natural soundscape. Noise from impacts would attenuate to natural ambient levels at distances ranging from 385 feet for the cordless drill/hammer to more than 4 miles for the jackhammer. When multiple pieces of machinery operate simultaneously, the attenuation distance increases. For example, noise from the loader diminishes to natural ambient at a distance of 3.2 miles, and the backhoe at a distance of 2 miles. When operated together, the combined noise attenuates to natural ambient at a distance of more than 4 miles. Use of this equipment would result in short-term, major, adverse effects on the natural soundscape, depending on distance from the source.

Restoration activities in zones 1B through 4, including recontouring of slopes, bank stabilization, creation and enhancement of step-pools, installation of temporary browsing exclosure fences, and debris removal and relocation in zones 2, 3, and 4 would require the use of heavy machinery. The types of equipment being used would vary in accordance with the restoration activity and location but could include the following: excavators, walking excavators, haulers, motorized blades, a helicopter, a jack hammer, backhoes, loaders, and other earth moving equipment. During the three month season, equipment would be used frequently and for extended time periods during the work day. Noise from mechanized equipment would attenuate to natural ambient levels at distances ranging from 385 feet for the cordless drill/hammer to more than 4 miles for the jackhammer. When operated together, the combined noise would attenuate to natural ambient at a distance of more than

4 miles. Use of this equipment would result in short-term, major adverse effects on the natural soundscape depending on distance from the source.

Under alternative C, the use of helicopters would be more frequent than under alternative B as a result of the additional equipment and supplies necessary to complete the restoration. Helicopter use would be estimated at an average of two flights per week. During these flights, effects on the natural soundscape would be short-term, local and regional, moderate to major, and adverse, depending on the distance from the helicopter and the number of flights.

Restoration work may take place simultaneously throughout zones 1B through 4 or may, at times, be concentrated in one area. This range of variability would result in a range of impacts for different zones in the project area. Short-term, adverse impacts on the natural soundscape within the project area would range from minor to major depending on distance from the source.

Additionally, temporary browsing exclosure fences would be removed from the site once the vegetation was established in 15 to 20 years. The removal process would require the use of heavy machinery and/or a helicopter periodically over the course of several days. During this period, equipment would be used frequently and for an extended time period during the work day. Sound levels would be the same as those described above. Depending on the location and the tools being used, use of this equipment, would result in short-term, localized, moderate to major, adverse effects on the natural soundscape

Tall willow established in the wetland would provide a buffer from human-caused noise generated outside of the wetland, such as visitor conversations on adjacent trails. This would slightly reduce the detectable noise in the wetland and would result in a local, long-term, negligible to minor, beneficial effect on the natural soundscape.

Resource protection measures to minimize impacts on the natural soundscape could include standard noise abatement mitigation measures described in alternative B.

Overnight Camps. Impacts on the soundscape from the addition of two temporary line camps would be the same as described under alternative B. Impacts from noise produced by emergency nighttime use of generators and human conversation in the camps would be short-term, major, and adverse. Impacts from emergency nighttime use of generators would be mitigated by using best available technology (see NPS Acoustical Toolbox; NPS 2010d), covering generators with noise-dampening enclosures, running the generators as little as possible, and limiting use of generators during acoustically sensitive periods (dawn and dusk).

Impacts from the temporary closure of the backcountry campsites would be the same as described under alternative B and would result in a slight beneficial impact on natural soundscapes.

Cumulative Impacts

Past, current, and foreseeable future actions that impact the natural soundscape within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on the natural soundscape would continue to be short-term, local and regional, moderate, and adverse.

Alternative C would result, overall, in short-term, major, adverse impacts on natural soundscape. The cumulative effects on the natural soundscape would continue to be short term, local and regional, major, and adverse. The actions associated with alternative C would have a substantial contribution to the cumulative impacts on the natural soundscape.

Conclusion

Under alternative C, impacts from the use of heavy machinery to implement option 1 or 2 in zone 1A and restoration activities in zones 1B through 4 would be short term, major, and adverse. Effects on the natural soundscape from the use of a helicopter to fly machinery and supplies in and out of the project area would be short-term, major, and adverse depending on the distance from the helicopter. Restoration work may take place in all zones simultaneously, or may be concentrated in one area. The sounds emitted by equipment would be audible frequently throughout the day up to 4 miles from the source.

Emergency nighttime use of a generator in both temporary line camps established in the project area would have short-term, adverse impacts of major intensity on the natural soundscape. Impacts from the temporary closure of the backcountry campsites would result in a slight beneficial impact on natural soundscapes, because noise would be audible up to 1.4 miles during sensitive times of the day.

Tall willow established in wetland would create a buffer from human-caused noise generated outside the wetland and would result in a local, long-term, negligible to minor, beneficial effect.

The cumulative effects on the natural soundscape would continue to be short term, local and regional, major, and adverse. The actions associated with alternative C would have a substantial contribution to the cumulative impacts on natural soundscape.

IMPACTS OF ALTERNATIVE D – THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Analysis

Mechanized Equipment and Hand Tools. Installation option 1 or 2 in zone 1A would utilize the same equipment as described under alternative B. As under alternative C, restoration activities in zones 1B through 4 would also utilize heavy machinery. The combined use of heavy machinery in all zones would increase noise levels across the project area. As under alternative B, restoration activities would take place during working hours for up to five months each year for two years.

Restoration activities under alternative D would be similar to those described under alternative C and would require the same mechanized equipment. However, impacts on the soundscape would be prolonged from increased debris removal in the alluvial fan in zone 2 despite removal of less debris in zone 4. Removal of debris would require use of an excavator and earth moving equipment to bring the debris to storage areas. These actions would result in short-term, adverse impacts of major intensity, depending on distance from the sources.

The use of helicopters under alternative D would be similar to that described under alternative C, with the potential for similar or a slight decrease in number of flights to accommodate less equipment and supplies that may be needed. During these flights, effects on the natural soundscape would be short term, local and regional, moderate to major, and adverse, depending on the distance from the helicopter and the number of flights.

Under alternative D, restoration work would most likely take place simultaneously throughout zones 1B through 4 and short-term impacts on the natural soundscape would range from minor to major and adverse depending on distance from the source.

Under alternative D, removal of temporary browsing exclosure fences in 15 to 20 years would be the same as described for alternative C over a larger area. Depending on the location and the tools being used, use of this equipment, would result in short-term, localized, moderate to major, adverse effects on the natural soundscape.

Tall willow established in the wetland would provide a buffer from human-caused noise generated outside of the wetland, such as visitor conversations on adjacent trails. This would reduce the detectable noise in the wetland to a small degree and would result in a local, long-term, negligible to minor, beneficial effect on the natural soundscape.

Resource protection measures to minimize impacts on the natural soundscape could include standard noise abatement mitigation measures described in alternative B.

Overnight Camps. Impacts on the soundscape from the addition of two temporary line camps would be the same as described under alternative B. Impacts from noise produced by emergency nighttime use of generators and human conversation in the camps would be short-term, major, and adverse. Impacts from emergency nighttime use of generators would be mitigated by using best available technology (see NPS Acoustical Toolbox; NPS 2010d), covering generators with noise-dampening enclosures, running the generators as little as possible, and limiting use of generators during acoustically sensitive periods (dawn and dusk).

Impacts from the temporary closure of the backcountry campsites would be the same as described under alternative B and would result in a slight beneficial impact on natural soundscapes.

Cumulative Impacts

Past, current, and foreseeable future actions that impact the natural soundscape within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on the natural soundscape would continue to be short term, local and regional, moderate, and adverse.

Alternative D would result, overall, in short-term, major, adverse impacts on natural soundscape. The cumulative effects on the natural soundscape would continue to be short term, local and regional, major, and adverse. The actions associated with alternative D would have a substantial contribution to the cumulative impacts on natural the soundscape.

Conclusion

Under alternative D, impacts from the use of heavy machinery to implement option 1 or 2 in zone 1A and restoration activities in zones 1B through 4 would be short term, major, and adverse. Effects on the natural soundscape from the use of a helicopter to fly machinery and supplies in and out of the project area would be short term, major, and adverse, depending on the distance from the helicopter. Restoration work would most likely take place simultaneously throughout zone 1B through 4. The sounds emitted by equipment would be audible frequently throughout the day up to 4 miles from the source.

Emergency nighttime use of a generator in both temporary line camps established in the project area would have short-term, adverse impacts of major intensity on the natural soundscape. Temporary closure of the backcountry campsites would result in a slight beneficial impact on natural soundscapes, because noise would be audible up to 1.4 miles during sensitive times of the day.

Tall willow established in wetland would create a buffer from human-caused noise generated outside the wetland and would result in a local, long-term, negligible to minor, beneficial effect.

Cumulative impacts on the natural soundscape would continue to be major, short term, local and regional, and adverse. This alternative's contribution to these effects would be substantial and adverse.

IMPACTS OF ALTERNATIVE E – MAXIMUM RESTORATION

Analysis

Mechanized Equipment and Hand Tools. Installation of option 1 or 2 in zone 1A would utilize the same equipment as described under alternative B. As under alternative C, restoration activities in zones 1B through 4 would also utilize heavy machinery. The combined use of heavy machinery in all zones would increase noise levels across the project area. Under alternative E, restoration activities would take place during working hours for up to five months each year for two to three years.

Restoration activities under alternative E would be similar to those described under alternative C and would require the same mechanized equipment. However, impacts on the soundscape would be prolonged from increased debris removal in the alluvial fan in zone 2 and removal of additional historical debris in zone 4. These actions would result in short-term, adverse impacts of major intensity, depending on distance from the sources.

The use of helicopters under alternative E would be similar to that described under alternative D. During these flights, effects on the natural soundscape would be short term, local and regional, moderate to major, and adverse, depending on the distance from the helicopter and the number of flights.

Under alternative E, restoration work would take place simultaneously throughout zones 1B through 4 and short-term impacts on the natural soundscape would range from minor to major and adverse depending on distance from the source.

Under alternative E, removal of temporary browsing exclosure fences in 15 to 20 years would be the same as described for alternative C and D, but over a larger area. Depending on the location and the tools being used, use of this equipment, would result in short-term, localized, moderate to major, adverse effects on the natural soundscape.

Tall willow established in the wetland would provide a buffer from human-caused noise generated outside the wetland, such as visitor conversations on adjacent trails. This would slightly reduce the detectable noise in the wetland and would result in a local, long-term, negligible to minor, beneficial effect on the natural soundscape.

Resource protection measures to minimize impacts on the natural soundscape could include standard noise abatement mitigation measures described in alternative B.

Overnight Camps. Impacts on the soundscape from the addition of two temporary line camps would be the same as described under alternative B. Impacts from noise produced by emergency nighttime use of generators and human conversation in the camps would be short term, major, and adverse. Mitigation for impacts from emergency nighttime use of generators would be mitigated by using best available technology (see NPS Acoustical Toolbox; NPS 2010d), covering generators with noise-dampening enclosures, running the generators as little as possible, and limiting use of generators during acoustically sensitive periods (dawn and dusk).

Impacts from the temporary closure of the backcountry campsites would be the same as described under alternative B and would result in a slight beneficial impact on natural soundscapes.

Cumulative Impacts

Past, current, and foreseeable future actions that impact the natural soundscape within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on the natural soundscape would continue to be short-term, local and regional, moderate, and adverse.

Alternative E would result, overall, in short-term, major, adverse impacts on natural soundscape. The cumulative effects on the natural soundscape would continue to be short term, local and regional, major, and adverse. The actions associated with alternative E would have a substantial contribution to the cumulative impacts on the natural soundscape.

Conclusion

Under alternative E, impacts from the use of heavy machinery to implement option 1 or 2 in zone 1A and restoration activities in zones 1B through 4 would be short term, major, and adverse. Effects on the natural soundscape from the use of a helicopter to fly machinery and supplies in and out of the project area would be short-term, major, and adverse, depending on the distance from the helicopter. Restoration work would take place simultaneously throughout zone 1B. The sounds emitted by equipment would be audible frequently throughout the day up to 4 miles from the source.

Emergency nighttime use of a generator in both temporary line camps established in the project area would have short-term, adverse impacts of major intensity on the natural soundscape. Temporary closure of the backcountry campsites would have a slight beneficial impact on natural soundscapes because noise would be audible up to 1.4 miles during sensitive times of the day.

Tall willow established in wetland would create a buffer from human-caused noise generated outside the wetland and would result in a local, long-term, negligible to minor, beneficial effect.

The cumulative effects on the natural soundscape would continue to be short term, local and regional, major, and adverse. The actions associated with alternative E would have a substantial contribution to the cumulative impacts on natural soundscape.

GEOLOGY AND SOILS

REGULATIONS, GUIDANCE, AND POLICIES

Three overarching environmental protection laws and policies guide the actions of the National Park Service in the management of the park and its resources: the NPS Organic Act of 1916, the National Environmental Policy Act and its implementing regulations, and the Omnibus Management Act. Together, these measures provide a framework and process for evaluating the impacts of the alternatives proposed in this environmental impact statement. Specifically, NPS *Management Policies* (2006a) directs the park service to understand and preserve soil resources of parks, and to prevent the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resources (Section 4.8.2.4.). From a larger perspective, NPS *Management Policies* (2006a) directs the National Park Service to manage streams to protect important stream processes, including flooding, erosion, and deposition, and to return disturbed areas to their natural conditions and processes. The National Park System Resource Protection Act (16 USC 590, et seq.) notes that soil erosion on federal lands is a concern and should be controlled and prevented.

METHODS AND ASSUMPTIONS FOR ANALYZING IMPACTS

Geographic Area Evaluated for Impacts

The geographic focus of this analysis is the area of the Upper Kawuneeche Valley impacted by the Grand Ditch breach. Impacts on geology and soils are evaluated for each of the zones defined by this environmental impact statement, as shown in figure 1.5, as well as the greater Upper Kawuneeche Valley.

Issues

Issues related to soils are categorized as follows: (1) areas of continued soil loss and erosion as a result of the 2003 breach; and (2) areas of deposition created by the 2003 breach.

- Continued soil loss - Areas exposed by the 2003 breach are located in zones 1 and 2 (figures [2.2 and 2.3]). This includes the slope immediately beneath and the gully in zone 1. Areas of exposed soils in these zones continue to be susceptible to erosion by direct precipitation and the resulting runoff. These processes perpetuate a cycle of instability, widen the area of erosion, continue soil loss, and continue to contribute to deposition.
- Buried soils, continued deposition - Areas of deposition created by the 2003 breach are located in zones 2, 3, and 4 (figures 2.4 through 2.7). These zones have extensive areas of poorly sorted sand, gravel, rocks, and boulders that range in thickness from inches to feet. Existing soils were buried under many of these deposits and these deposits provide a poor substitute for those soils. In addition to the impacts resulting from existing areas of deposition, future precipitation, runoff, and overbank flows would likely re-mobilize those deposits and move them downstream to bury soils in other areas.
- Changes in landforms - Changes in landform include the eroded hillside beneath the breach site; the gully created in zone 1; and large deposition areas in zones 2, 3, and 4. Erosional features may expand, and depositional features may shift or expand.

Issues related to erosion and deposition that impact the flows in and the structure of Lulu Creek, the Colorado River, and their tributaries are discussed in the Water Resources section. Please keep in mind that changes in the structure of stream channels will influence the degree to which flows access areas adjacent to the stream and influence the sediments removed from and deposited in those areas.

Assumptions

Assumptions specifically related to the analysis of potential impacts on soils are described below.

- The area evaluated for impacts on soils and areas of deposition are those outside the channels of Lulu Creek, the Colorado River, and their tributaries. The extent of these areas depend on the alternative selected because each alternative differs in the extent of in-stream restoration conducted.
- Erosion and deposition of sediments are natural processes in the project area and are required for the healthy functioning of stream ecosystems. This applies to sediments delivered by natural processes as well as those produced by the 2003 breach.
- The amount of sediment delivered to the system by the 2003 breach was large and has adversely impacted the riparian ecosystem in the project area. However, rock slides and debris flows have occurred in the valley in the past and will occur in the future.
- The debris fan at the confluence of Lulu Creek and the Colorado River is a primary source of debris available for transport downstream.
- High streamflows would continue to redistribute sediments and breach debris and the consequences of those processes could be either beneficial or adverse depending on the resources and location.
- Redistribution of sediment and breach debris as a result of high flow events would continue to have adverse effects on both newly established and extant vegetation.

Assessment Methods

The process used to assess impacts on soils includes (1) identify any assumptions used to formulate the analysis; (2) identify issues of concern related to soils that have been raised through internal and public scoping; (3) identify thresholds used to define the level of impact resulting from each alternative; (4) determine the potential impacts of each alternative; and (5) combine the alternative's impacts with cumulative impacts from other plans and projects and determine an overall level of impact for each alternative. Information on soils was evaluated and determined qualitatively based on the professional judgment of NPS staff and consultants. Primary sources of information used in this analysis included existing park management documents, NPS policy documents, published reports and scientific literature, and unpublished observations and insights from park staff.

Impact Threshold Definitions

Negligible: Effects on geology and soils would not result in measurable changes to factors such as soil erosion, deposition, character, structure, and productivity, or to geologic form and function. There would be no discernible changes in the ability of the soil to support native vegetation. Mitigation measures would not be required.

Minor: Effects on geology and soils would be detectable and would result in small, measurable changes in factors such as soil erosion, deposition, character, structure, and productivity, or to geologic form and function. There would be detectable changes in the ability of the soil to support native vegetation. With discontinuation of disturbance, the resource would recover without assistance. Mitigation may be needed to offset adverse effects. If needed, mitigation would likely succeed.

Moderate: Effects on geology and soils would result in readily detectable changes to factors such as soil erosion, deposition, character, structure, and productivity, or geologic form and function. Changes would alter resource functions. The ability of the soil to support native vegetation would be appreciably changed. With discontinuation of disturbance, the resource would likely return to its natural state with some intervention. Mitigation may be needed to offset adverse effects. If needed, mitigation may succeed.

Major: Effects on geology and soils would be severe or exceptional and result in appreciable changes to factors such as soil erosion, deposition, character, structure, productivity, or geologic form and function. Critical soil and landscape characteristics would be altered. The actions would have substantial, highly noticeable influences on the ability of the soil to support native vegetation. Mitigation may be needed to offset adverse effects. If needed, mitigation success would not be guaranteed.

Beneficial effects would increase soil character, structure, and productivity; enhance geologic form and function; reduce soil erodability or deposition; or otherwise enhance the ability of soils to support vegetation. Soils conditions would move toward restoration of reference conditions.

Adverse effects on soils would reduce soil character, structure, and productivity, or geologic form and function, increase soil erodability, or otherwise diminish the natural ability of soils to support vegetation. Soil conditions would degrade further from reference conditions.

Short-term: Effects would cease within one year following implementation of the action.

Long-term: Effects would extend more than one year beyond implementation of the action.

IMPACTS OF ALTERNATIVE A – NO ACTION / CONTINUE CURRENT MANAGEMENT

Analysis

Under alternative A, soils would be impacted by continued erosion and deposition of areas affected by the 2003 breach. The park would continue to rely on natural processes to restore the soil conditions in the area impacted by the 2003 breach. No active restoration efforts would be pursued under alternative A.

Continued Soil Loss. Areas in zones 1 and 2 that were eroded during the 2003 breach would continue to be subject to erosion, resulting in the continued loss of soils, continued deposition in down-gradient area, and limited or non-existent local soil formation. Continuation of these conditions would have long-term, local, moderate, and adverse impacts on soils.

Buried Soils, Continued Deposition. Areas of deposition in zones 2, 3, and 4 would continue to be subject to movement and redistribution by precipitation, runoff, and overbank channel flows during high water. Continuation of these conditions would have long-term, local, moderate, and adverse impacts on soils because burial of areas downstream and down-gradient would continue. However, existing deposition sites would continue to provide marginal rooting material for native vegetation.

Changes in Landforms. Changes in landform created by the breach would remain. Features such as the eroded hillside beneath the breached site and the gully created in zone 1 would likely expand, and large deposition areas would remain, likely change shape, decrease in some areas and expand in others. Continuation of these conditions would have long-term, local, moderate, and adverse impacts on soils because they would continue to erode and contribute debris to areas down-gradient and downstream.

Cumulative Impacts

Past, present, and reasonably foreseeable actions with potential to affect geology and soils in the project area are identified in the purpose and need chapter of this document. These plans and projects include the park's Vegetation Restoration Management Plan (2006b), Backcountry Wilderness Management Plan (2001a, currently under revision), Elk and Vegetation Management Plan (2007c), Bark Beetle Management Plan (2005a), and Invasive Exotic Plant Management Plan (2003b). Each of these plans inherently conserves and protects park resources and would contribute to improving soil conditions or preventing or reducing loss of soils. As a result, these plans would all contribute beneficial effects on geology and soils in the long term.

Collectively, the effects of these actions would result in long-term, local, and minor beneficial effects on geology and soils.

Alternative A would have long-term, local, moderate, and adverse impacts on soils. The cumulative effects on geology and soils would continue to be long term, local, moderate, and adverse. The actions associated with alternative A would have a substantial contribution to these cumulative impacts.

Conclusion

The impact of alternative A on soils would be long-term, local, moderate, and adverse. Adverse impacts would result from continued degradation of areas eroded during the 2003 breach, and the continued existence of large areas of deposition. The cumulative effect of alternative A and other plans and projects would be long-term, local, moderate, and adverse, with alternative A contributing substantially to the overall adverse effect. The actions associated with alternative A would have a substantial contribution to these cumulative impacts.

IMPACTS OF ALTERNATIVE B – MINIMAL RESTORATION

Analysis

Under alternative B, soils would be impacted primarily by ongoing efforts to stabilize and revegetate areas affected by the 2003 breach.

The following aspects of alternative B would influence soils in the project area.

- **Zone 1B –** stabilize area by revegetation in spot locations.
- **Zone 2 –** stabilize area through revegetation; stabilize riparian areas with spot revegetation in braided sections of Lulu Creek as well as outside the channel above the ordinary high water mark; protect channel with small boulders.
- **Zone 3** – revegetate outside the active channel with willows, other riparian species.
- **Zone 4** – revegetate bare areas with wetland turf or sedge sprigs; stabilize head-cuts at spot locations, and protect erosion-prone banks.

Continued Soil Loss. Soil stabilization activities in zones 1 and 2 would have long-term, local, and minor beneficial impacts on soils. Revegetation in uplands, wetlands, and in areas adjacent to channels would slow the erosion of exposed areas and accelerate the process of soil formation in the project area.

Buried Soils, Continued Deposition. Areas of deposition in zones 2, 3, and 4 represent long-term, local, moderate, and adverse impacts on soils. Existing areas of deposition would continue to be subject to movement and redistribution downstream and down-gradient by precipitation, runoff, and overbank channel flows during high water. Existing deposition sites would continue to provide marginal rooting materials for native vegetation. However, native soils would remain buried, and their character, structure, and productivity would be highly altered.

Changes in Landforms. For the most part, the landforms created by the breach would remain under alternative B. Large areas of deposition would still exist, although they may change shape and be redistributed, decreasing in some areas and expanding in others. As a continuing source of downstream sediments, these conditions would have long-term, local, moderate, and adverse impacts on soils. Efforts to reduce soil erosion would somewhat reduce sediment production from areas adjacent to stream channels.

Taken together, impacts from soil loss, deposition, and changes in landforms would be long-term, local, moderate, and adverse. Alternative B differs from alternative A in that alternative B includes efforts to assist and accelerate natural process of revegetation and soil formation. Alternative A does not include such efforts and relies instead on unaided natural restoration processes.

Cumulative Impacts

Past, current, and foreseeable future actions that impact the soils and geology would be the same as those described for alternative A. Collectively, the effects of these actions would result in long-term, local, and minor beneficial effects on geology and soils.

Overall, alternative B would have long-term, local, moderate, and adverse impacts on soils. The cumulative impact of alternative B and other plans and projects would be long-term, local, moderate, and adverse. The benefits provided by other plans would not be sufficient to offset the impacts and ongoing processes associated with the breach. The actions associated with alternative B would have a substantial contribution to these cumulative impacts.

Conclusion

The impact of alternative B on soils would be long-term, local, moderate, and adverse. Adverse impacts on soils buried under large areas of deposition would remain, as would adverse impacts from continued, but more limited, erosion and deposition in the project area. Minor, long-term benefits would result from efforts to stabilize and revegetate areas of erosion and deposition. The cumulative effect of alternative B and other plans and projects would be long-term, local, moderate, and adverse. The actions associated with alternative B would have a substantial contribution to these cumulative impacts.

IMPACTS OF ALTERNATIVE C – HIGH RESTORATION

Analysis

Under alternative C, soils would be affected primarily by recontouring impacted areas, removing deposits (primarily those deposited in zone 4), and stabilizing and revegetating within the project area. The following aspects of alternative C would influence soils in the project area.

- **Zone 1B** – stabilize undercut slopes by conducting "major recontouring"; revegetate with seeding and vegetation mats through-out.

- **Zone 2** – stabilize bed and bank with boulders and large woody material; revegetate with upland species; recontour and protect 50% of channel; create more stable bank configuration; revegetate with riparian species outside the channel and above the ordinary high water mark; create a single channel through the alluvial fan; create terraces with materials removed from the alluvial fan, and revegetate with upland species.
- **Zone 3** – relocate large woody material to spot locations to minimize bank erosion, and revegetate outside the active channel with cottonwoods and other riparian species, and revegetate upland areas with appropriate species; make a series of cuts in berm to allow channel overflow to the east during high-flow events; enhance wetland conditions by reconnecting with existing channel; create an area in Dutch Creek drainage for storage of debris removed from the Lulu City wetland; preserve the creek's active channel; establish a staging area and camp for restoration workers.
- **Zone 4** – excavate debris to allow main channel to return to historical channel; remove sufficient debris to restore conditions suitable for tall willow complex and to maintain historical channel location; excavate channel to historical depth, width, slope; revegetate bare areas with willows, and wetland species where appropriate; implement bank stabilization to reduce erosion; fill in the abandoned Colorado River channel with materials suitable for revegetating with willow complex and revegetate with willows.

Continued Soil Loss. Recontouring impacted slopes in zone 1 and soil stabilization activities in zones 1 and 2 would have long-term, local, minor to moderate, beneficial impacts on soils. Recontouring would decrease slope severity and thereby lessen erosion and improve the success of revegetation efforts. Like alternative B, revegetation in uplands, wetlands, and in areas adjacent to channels would slow the erosion of exposed areas and accelerate the process of soil formation in the project area.

Buried Soils, Continued Deposition. Areas of deposition would be excavated and removed. Short-term, minor, local adverse effects associated with mechanized equipment use and soil compaction would be addressed with restoration following completion of excavation actions. Overall, excavation would have long-term, local, minor to moderate, beneficial impacts by uncovering existing soils and restoring their role in the local ecosystem. Remaining deposits from the 2003 breach provides marginal rooting materials for native vegetation, a long-term, local benefit. The rate and extent of future sediment deposition in the wetland would be reduced by removing a portion of the alluvial fan from zone 2 and rerouting Colorado River flows into the historical central channel. However, sediment present in the alluvial fan would still be subject to erosion during high flow, which would represent an ongoing source of sediment to downstream habitats, a long-term, local, minor to moderate, and adverse impact.

Changes in Landforms. Recontouring in zone 1 and the removal of breach deposits in several areas would have long-term, local, minor to moderate, beneficial impacts by returning several areas to a configuration similar to pre-breach. Debris and sediment would be partially removed from the alluvial fan at the confluence of Lulu Creek and the Colorado River, reducing the amount of sediment and debris available for downstream transport during low-flow conditions. However during high-flow events, debris from the 2003 breach may be transported downstream. Terraces built from disposed materials would create new landforms in zones 2 and 3. Because existing soils would be buried beneath these terraces, new landforms would have long-term, local, moderate, and adverse impacts. A staging area would be established in zone 3, with short-term, local, moderate, and adverse impacts from burial and compaction. These and many other areas would be revegetated, which would slow the erosion of exposed areas and accelerate the process of soil formation in the project area, thus providing long-term, local, minor, beneficial impacts on soils. Efforts at bank stabilization would somewhat reduce sediment production from areas adjacent to stream channels.

Taken together, impacts from soil loss, deposition, and changes in landforms under alternative C would be long-term, local, minor to moderate, and beneficial impacts. Alternative C differs from alternative A in that alternative C includes (1) recontouring of areas impacted by the 2003 breach, (2) removal of debris deposits in several areas, and (3) seeding and revegetation efforts that assist and accelerate natural process of revegetation and soil formation.

Cumulative Impacts

Past, current, and foreseeable future actions that impact the soils and geology would be the same as those described for alternative A. Collectively, the effects of these actions would result in long-term, local, minor, beneficial effects on geology and soils.

The impacts of alternative C would be long term, local, minor to moderate, and beneficial. The cumulative impact of alternative C and other plans and projects would be long-term, local, minor to moderate, and beneficial. The actions associated with alternative C would have a substantial contribution to these cumulative impacts.

Conclusion

The impact of alternative C on soils would be long term, local, minor to moderate, and beneficial. Benefits would result from recontouring impacted areas, removing deposits, and stabilizing and revegetating within the project area. Most adverse impacts are short term and should respond well to mitigation. The cumulative effect of alternative C and other plans and projects would be long-term, local, minor to moderate, and beneficial. The actions associated with alternative C would have a substantial contribution to these cumulative impacts.

IMPACTS OF ALTERNATIVE D – THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Analysis

Under alternative D, soils would be affected by localized recontouring of highly unstable areas along banks and slopes, removing the large amount of debris deposited in the alluvial fan of zone 2 and creating a single channel through this zone, and stabilizing and revegetating within the project area.

The following aspects of alternative D would influence soils in the project area.

- **Zone 1B –** stabilize by revegetate through-out entire gully.
- **Zone 2** – remove debris forming the alluvial fan at the confluence of Lulu Creek and the Colorado River, and reconfigure to create a single channel; stabilize banks and braided sections through seeding and vegetation mats, and recontour at spot locations, and protect with existing boulders; excavate debris for the terraces to be created in zone 2, and revegetate with upland species; revegetate bare areas above the ordinary high water mark with upland species.
- **Zone 3** – revegetate outside active channel with willows, other riparian species; make series of cuts in berm to allow overflow to east during high-flow events; enhance wetland conditions by reconnecting the area to existing channel; establish tall willow complex; create area in Dutch Creek drainage to store debris from zone 2 and the Lulu City wetland; revegetate with upland

species; preserve creek's active channel; create a staging area and camp for restoration workers.

- **Zone 4** – excavate debris to allow main channel of Colorado River to return to historical channel; remove sufficient debris to restore conditions suitable for tall willow complex and to maintain Colorado River historical channel location; revegetate with willows and wetland species; implement bank stabilization with boulders to reduce erosion and to accommodate increased flows; revegetate bare areas with sedges and wetland grasses; fill in the abandoned Colorado River channel with materials suitable for willow complex and revegetate with willows.

Continued Soil Loss. Many aspects of alternative D that address continued soil loss are the same as those discussed under alternative B, and those aspects would also have the same impacts on soils. Revegetation activities would occur along zones 1, 2, and 3 to stabilize soils on slopes and streambanks. This would have long-term, local, minor, beneficial effects.

Buried Soils, Continued Deposition. Many aspects of alternative D that address buried soils and continued deposition are the same as those discussed under alternative C, and those aspects would have the same impacts on soils. Additional aspects of alternative D that address buried soils and continued deposition include the more extensive removal of debris from the alluvial fan at the confluence of Lulu Creek and the Colorado River. This would eliminate a large source of sediments impacting downstream habitats, a long-term, local, major, beneficial impact.

Changes in Landforms. Many aspects of alternative D that address changes in landforms are the same as those discussed under alternative C, and those aspects would have the same impacts on soils. Additional aspects of alternative D that address changes in landforms include more extensive removal of material from the alluvial fan at the confluence of Lulu Creek and the Colorado River, reducing greatly the amount of sediment and debris available for downstream transport. The level of beneficial impacts would be long term, local, and moderate to major.

Taken together, impacts from soil loss, deposition, and changes in landforms under alternative D would be long term, local, moderate to major, and beneficial. Alternative D differs from alternative A in that alternative D includes (1) localized recontouring of highly erodible areas, (2) removal of debris deposits in several areas; (3) creating a staging area; and (4) revegetation efforts that assist and accelerate natural process of revegetation and soil formation. Alternative A does not include such efforts and relies instead on unaided natural restoration processes.

Cumulative Impacts

Past, current, and foreseeable future actions that impact the soils and geology would be the same as those described for alternative A. Collectively, the effects of these actions would result in long-term, local, minor, beneficial effects on geology and soils.

The impacts of alternative D would be long term, local, major, and beneficial. The cumulative impact of alternative D and other plans and projects would continue to be long term, local, major, and beneficial. The actions associated with alternative D would have a substantial contribution to these cumulative impacts.

Conclusion

The impact of alternative D on soils would be long term, local, major, and beneficial. Benefits would result from localized recontouring impacted areas, removing large debris deposits, and stabilizing and revegetating within the project area. Most adverse impacts are short term and should respond well to mitigation. The cumulative effect of alternative D and other plans and projects would be long term, local, major, and beneficial. The actions associated with alternative D would have a substantial contribution to these cumulative impacts.

IMPACTS OF ALTERNATIVE E – MAXIMUM RESTORATION

Analysis

Under alternative E, soils would be affected in ways similar to those described in alternative C. Differences include filling in the gully in zone 1B to pre-breach contours, more extensive removal of debris in zone 2, creation of a single channel through that zone, creation of a temporary haul road to assist restoration activities, and more extensive seeding and revegetation activity throughout the project area.

The following aspects of alternative E would influence soils in the project area.

- **Zone 1B** – fill gully to pre-2003 contours with debris from zones 1B and 2 and revegetate with native vegetation.
- **Zone 2** – stabilize banks through recontouring; revegetate outside the channel and above the ordinary high water mark with upland species; remove debris from alluvial fan and deposit in terraces to be constructed in zone 2, and revegetate those terraces with upland species.
- **Zone 3** – revegetate outside active channel with native vegetation; leave channel in current condition and reconnect surface water supply to historical floodplain; revegetate bare areas on west bank of Colorado River with riparian species; excavate entire berm deposit to allow channel overflow to the east during high-flow events; establish tall willow complex; create an area in the Dutch Creek drainage to store materials excavated from zone 2 and the Lulu City wetland; preserve creek's active channel; develop a staging area and camp for restoration worker; construct a temporary haul road with debris from the Lulu City wetland and zone 2 to accommodate restoration activities; these areas would be restored after project completion.
- **Zone 4** – construct a temporary haul road with debris from the Lulu City wetland and zone 2 to accommodate restoration activities; excavate debris to allow main channel of Colorado River to return to the historical channel; remove sufficient debris to restore conditions suitable for tall willow complex and to maintain Colorado River historical channel location; revegetate this area with willows and wetland species, and revegetate other bare areas with willows; remove debris to expose surface of pre-existing fen and revegetate with fen species.

Continued Soil Loss. Many aspects of alternative E that address continued soil loss are the same as those discussed under alternative C, and those aspects would have the same impacts on soils. Additional aspects of alternative E that address continued soil loss include filling in the gully in zone 1B to pre-breach contours and more extensive revegetation activities. Impacts in zone 1B would be long term, local, major, and beneficial.

Buried Soils, Continued Deposition. Many aspects of alternative E that address buried soils and continued deposition are the same as those discussed under alternative C, and those aspects would have the same impacts on soils. Additional aspects of alternative E that address buried soils and continued deposition include more extensive removal of debris in zone 2 and creation of a temporary haul road. The road would have short-term, localized, moderate to major, adverse effects on soils. The temporary haul road would be restored to pre-disturbance conditions by recontouring and vegetating with native vegetation. The additional debris removal and extensive bank and slope stabilization would have long-term, local, major, beneficial impacts.

Changes in Landforms. Many aspects of alternative E that address changes in landforms are the same as those discussed under alternative C, and those aspects would have the same impacts on soils. Additional aspects of alternative E that address changes in landforms include filling the gully in zone 1B to pre-2003 contours and creation of a temporary haul road to support restoration activities. The haul road would be a temporary change in landforms. Soil compaction would occur as mechanized equipment uses the haul road; however, the road would be restored following completion of the project, and there would be no long-term adverse effects on soils. These differences would not significantly alter the overall soil impacts (i.e., long term, local, major, and beneficial).

Taken together, impacts from soil loss, deposition, and changes in landforms under alternative E would be long term, local, major, and beneficial. Alternative E differs from alternative A in that alternative E includes (1) filling in the gully in zone 1B to pre-2003 contours; (2) removal of debris deposits in several areas, (3) creating a staging area and temporary haul road; and (4) revegetation efforts that assist and accelerate natural process of revegetation and soil formation. Alternative A does not include such efforts and relies instead on unaided natural restoration processes.

Cumulative Impacts

Past, current, and foreseeable future actions that impact the soils and geology would be the same as those described for alternative A. Collectively, the effects of these actions would result in long-term, local, minor, beneficial effects on geology and soils.

The impacts of alternative E would be long term, local, major, and beneficial. The cumulative impact of alternative E and other plans and projects would continue to be long term, local, major, and beneficial. The actions associated with alternative E would have a substantial contribution to these cumulative impacts.

Conclusion

The impact of alternative E on soils would be long term, local, major, and beneficial. Benefits would result from widespread recontouring and filling in impacted areas, removing large debris deposits, and extensive stabilizing and revegetating within the project area. Most adverse impacts are short-term and should respond well to mitigation. The cumulative effect of alternative E and other plans and projects would long term, local, major, and beneficial. The actions associated with alternative E would have a substantial contribution to these cumulative impacts.

WATER RESOURCES

REGULATIONS, GUIDANCE, AND POLICIES

National Park Service Laws and Policies

Three overarching environmental protection laws and policies guide the actions of the National Park Service in the management of the park and its resources: the National Park Service Organic Act of 1916, the National Environmental Policy Act and its implementing regulations, and the Omnibus Management Act. For a complete discussion of these and other guiding regulations, refer to the section “Laws, Regulations, and Policies” in the “Purpose of and Need for Action” chapter. Collectively, these guiding regulations provide a framework and process for evaluating the impacts of the alternatives proposed in this environmental impact statement.

Management Policies states that the “fundamental purpose” of the national park system begins with a mandate to conserve park resources and values and provide for the public enjoyment of the park’s resources and values to the extent that the resources will be left unimpaired for future generations. Section 1.4.6 identifies water resources as park resources, while Section 4.6.1 states the Service will “perpetuate surface waters and ground waters as integral components of park aquatic and terrestrial ecosystems.” Section 4.6.3 establishes that pollution of surface and groundwaters by both point and non-point sources can impair the natural functioning of aquatic and terrestrial ecosystems and diminish the utility of park waters for visitor use and enjoyment. Furthermore, it provides for the avoidance, wherever possible, of the pollution of park surface water and groundwater by human activities occurring within and outside the park. Section 4.6.3 also directs the National Park Service to:

- Work with appropriate governmental bodies to obtain the highest possible standards available under the Clean Water Act for the protection for park waters;
- Take all necessary actions to maintain or restore the quality of surface waters and groundwaters within the parks consistent with the Clean Water Act and all other applicable federal, state, and local laws and regulations; and
- Enter into agreements with other agencies and governing bodies, as appropriate, to secure their cooperation in maintaining or restoring the quality of park water resources (NPS 2006a).

Section 4.6.4 states that in managing floodplains on park lands, the National Park Service will manage for the preservation of floodplain values, minimize potentially hazardous conditions associated with flooding, and comply with the Organic Act and all other federal laws and executive orders related to managing activities on flood-prone areas, including Executive Order 11988 (Floodplain Management). The National Park Service will manage floodplains to protect, preserve, and restore the natural resources and functions of floodplains and to avoid support of floodplain development and actions that could adversely affect floodplain natural resources and functions or increase flood risks. Management will also avoid the environmental effects associated with the occupancy and modification of floodplains.

If inappropriate human activity or development is proposed inside a floodplain, then the National Park Service must prepare and approve a floodplain statement of findings in accordance with procedures described in Director’s Order 77-2 (Floodplain Management). In this restoration project, a floodplain statement of findings would not be required because inappropriate human development in the floodplain is not proposed; human life and property would not be put at risk by the project or changes to floodplains; and floodplain functions would be beneficially enhanced.

Section 4.6.5 states that the National Park Service will manage wetlands in compliance with NPS mandates and the requirements of Executive Order 11990 (Protection of Wetlands), the Clean Water Act, and other federal laws related to managing activities in wetlands according to procedures described in Director's Order 77-1 (Wetland Protection). The National Park Service will manage wetlands to prevent the destruction, loss, or degradation of wetlands; preserve and enhance the natural and beneficial values of wetlands; and avoid support of new construction in wetlands unless there are no practicable alternatives and the proposed action includes all practicable measures to minimize harm to wetlands. The National Park Service will implement a "no-net-loss-of-wetlands" policy, including restoring wetlands that have been degraded by human actions to predisturbance characteristics or functions.

Actions proposed by the National Park Service that have the potential to cause adverse effects must be addressed by an environmental assessment or environmental impact statement. If the NPS preferred alternative would result in adverse impacts on wetlands, a statement of findings must be prepared and approved in accordance with Director's Order #77-1 (Wetland Protection). However, actions designed to restore degraded (or completely lost) wetland, stream, riparian, or other aquatic habitats or ecological processes may be excepted from the statement of findings and compensation requirements (NPS 2011k). Because the proposed action would restore degraded and completely lost wetlands, streams and riparian areas, a wetland statement of finding will not be required for this environmental impact statement.

Section 4.6.6 states that the National Park Service will manage watersheds as complete hydrologic systems and minimize human-caused disturbance to the natural upland processes that deliver water, sediment, and woody material to streams. These processes include runoff, erosion, meteorological events, mass movement, and other factors. The National Park Service will manage streams to protect stream processes that create habitat features such as floodplains, riparian systems, woody material accumulations, terraces, gravel bars, riffles, and pools. Stream processes include flooding, stream migration, and associated erosion and deposition (NPS 2006a).

Section 4.1.5 provides for the restoration of natural functions and processes in parks resulting from human disturbances, including the contamination of water; changes to hydrologic patterns and sediment transport, the acceleration of erosion and sedimentation, and the disruption of natural processes. The Service is directed to seek to return such disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the resource damages are situated (NPS 2006a).

Clean Water Act

Water quality is regulated under provisions of the federal Clean Water Act.

Section 402 regulates discharges of point sources of pollution into waters of the United States under the National Pollutant Discharge Elimination System permit program. Discharges from construction activities that cause disturbance to 1 acre or more of land require a National Pollutant Discharge Elimination System stormwater construction permit. In Colorado, Environmental Protection Agency Region VIII is the authorized authority for issuing National Pollutant Discharge Elimination System permits for federal facilities.

Section 404 addresses dredging or the discharge of fill materials into jurisdictional wetlands and water of the United States. Authorization to discharge fill materials is jointly administered by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency.

Section 401 of the Clean Water Act requires certification by the Colorado Department of Public Health and Environment that sets conditions for federally issued Section 402 and 404 permits to ensure that the activity will comply with state water quality standards. This certification is required before an Environmental Protection Agency National Pollutant Discharge Elimination System or Section 404 authorization can be issued for a project.

Stormwater construction permits would be required for restoration features in waters and wetlands that disturbs more than 1 acre of land. In Rocky Mountain National Park, stormwater construction permits are issued by the U.S. Environmental Protection Agency rather than the Colorado Department of Public Health and Environment because the state does not have jurisdiction on federal lands (Rosenlieb 2011). Disposal of water that accumulates during restoration activities would require a stormwater construction permit and may be allowed with the implementation of specific best management practices.

Colorado Water Quality Control Act

The Colorado Water Quality Control Act through its implementing regulations establishes basic water quality standards, an antidegradation rule and its implementation process, a system for classifying state surface waters, a system for assigning water quality standards, and for establishing beneficial use categories for the state surface waters of Colorado. The Colorado Department of Public Health and Environment, Water Quality Control Commission establishes the policies. The Water Quality Control Division implements the policies and regulations.

METHODS AND ASSUMPTIONS FOR ANALYZING IMPACTS

Geographic Area Evaluated for Impacts

The geographic area evaluated for effects on water quality, hydrology, and stream channel morphology extend from the headwaters of Lulu Creek and the Colorado River downstream to the confluence of the Colorado River with Shadow Mountain Lake. This area includes the main stream channels, their floodplains, and the wetlands that are hydrologically connected to these waters.

The terms used to define the extent of a particular effect or impact include the following:

Local effects of an action would affect water resources within relatively small areas within the park, such as a particular stream channel, drainage, or portion of a wetland.

Parkwide effects would affect water resources west of the Continental Divide within the Colorado River drainage in Rocky Mountain National Park.

Regional effects could extend to areas outside the park.

Issues

Internal and public scoping processes identified the following major concerns related to water resources:

Effects on Water Quality. The breach has resulted in periods of increased turbidity during precipitation due to hillside and streambank erosion and to the mobilization of debris in stream channels and adjacent banks during periods of high flow. Restoration activities to control erosion and revegetate current unvegetated areas could also result in short-term increases in soil erosion. Alternatives that stabilize slopes, alter vegetative cover and hydrology, and restore plant communities could improve soils and reduce erosion. Potential water quality changes that could increase suspended sediments or nutrients transport downstream to the Town of Grand Lake and Shadow Mountain Lake were concerns.

Effects on Surface and Groundwater Hydrology. The breach has altered the areas surface and groundwater hydrology from natural conditions. Restoration of the Lulu Creek and Colorado River stream channels could restore and affect hydrological processes in those areas as well as areas downstream.

Effects on Stream Channel, Floodplain, and Wetland Morphology. The breach has altered the stream channel and floodplain of Lulu Creek and the Colorado River from their natural conditions. Sediment deposition and alterations in hydrological condition have affected structure and function of the Lulu City wetland. Restoration could involve restoring the stream channel, redistributing sediment that has built up in the Lulu City wetland and removing excess downed timber from the stream channels that would affect the floodplain and wetland morphology in the area.

Assumptions

Several guiding assumptions were made to provide context for the analysis of water quality, hydrology, and stream channel morphology. These assumptions are described below.

- The outstanding waters designation of the streams and wetlands will need to be considered in designing the restoration activities.
- The debris fan at the confluence of Lulu Creek and Colorado River is a primary source of debris and sediment available for transport downstream.
- The Lulu City wetland water supply comes from four sources: direct snowmelt and rain, sideslope groundwater, surface water from the Colorado River, and groundwater from the Colorado River.
- The reference wetland vegetation condition in the Lulu City wetland is a complex of tall willow species (primarily mountain willow and Drummond willow), interspersed with water sedge.
- The gully and the eroded and enlarged Lulu Creek channel will not be refilled to match the Sawmill Creek reference condition. The current elevation and grade of the Lulu Creek channel will be left in its current condition. Attempting to bring the creek channel bed back to the pre-breach elevation would be too environmentally disruptive and would have a high potential for failing under the site's constraints of steep slopes and occasional severe snowmelt runoff conditions.
- Groundwater profiles would follow the ground surface topography and slope after the excavation of 2003 or older debris deposits in the Lulu City wetland.
- The same seasonal ground surface to water table depth relationships would continue to exist after the excavation of 2003 or older debris deposits in the Lulu City wetland.
- In the Lulu City wetland, suitable groundwater to surface elevations and groundwater movement conditions would be achieved by making site modifications based on monitoring of hydrologic conditions after the initial construction actions are completed.
- The tributary created in zone 2, area B would remain intact.

Assessment Methods

The water resources impact analysis is structured to separately address water quality, hydrology, and stream channel morphology so that each of these aspects can be systematically evaluated. The analysis addresses each water body separately as appropriate because water characteristics vary substantially by restoration zone.

Briefly, zone 1 extends from the top of the existing gully along the Grand Ditch service road to the start of streamflow in the bottom of the eroded gully. Zone 2 extends from the appearance of channel flow in the eroded gully to the confluence of Lulu Creek with the Colorado River. Zone 3 includes the Colorado River from the Lulu Creek confluence downstream to the start of floodplain meanders into the Lulu City wetland. Finally, zone 4 includes the short section of Colorado River upstream of the Lulu City wetland and the entire wetland downstream to its end on the river. Limited water quality information (Clow and Mast 2004) is available for Lulu Creek and the Colorado River but not for the Lulu City wetland in the restoration area.

The other plans and projects whose effects could cumulatively combine with the effects of the Grand Ditch breach restoration alternatives were presented in chapter 1. Only plans and projects that would have effects on water resources within the general geographic area analyzed are considered in the assessment of cumulative effects on water resources. The cumulative effects analyses for each of the alternatives evaluates the effects of the other plans and projects on a particular resource, adds the effects identified by the specific restoration alternative, and then identifies the total cumulative effect, including the degree that the restoration alternative contributes to the overall cumulative effect.

Impact Threshold Definitions for Water Quality

Negligible: Effects would not be measurable. Water quality parameters would be well within all water quality standards for the designated use (for example cold-water aquatic life). Water quality would be within the normal historical variability.

Minor: Measurable changes from historical norms would occur, but water quality changes would be within the range of historical variability. All water quality parameters would be within water quality standards for the designated use. State water quality antidegradation policies would not be violated. Mitigation measures, if required, would be successful.

Moderate: Water quality would be outside the range of normal variability. However, while changes to water quality or flows would be readily apparent, water quality parameters would be within water quality standards for the designated use. State water quality antidegradation policies would not be violated. Mitigation would probably be necessary to offset adverse effects and would likely be successful.

Major: Changes to water quality would be readily apparent and severe or exceptional. Some water quality parameters for the designated use would periodically be equaled or exceeded. State water quality antidegradation policies may be violated. Extensive mitigation would be needed to offset adverse effects, and its success would not be assured.

Beneficial effects would improve water quality toward reference conditions.

Adverse effects would degrade water quality.

Short-term: Effects would cease within three years following implementation of the action.

Long-term: Effects would extend more than three years beyond implementation of a restoration action.

Impact Threshold Definitions for Hydrology and Stream Channel Morphology

Negligible: Surface water or groundwater hydrology or channel morphology would not be affected or the effect would not be measurable. Flows would be within the range of natural variability. There would be no detectable change to sediment deposition or transport rates in the project area or downstream. Mitigation measures would not be required.

Minor: The effects on surface water or groundwater hydrology or channel morphology would be detectable, but effects on physical conditions that control hydrology or channel morphology would be small. Measurable changes from historical norms would occur, but flows would be within the range of natural variability. There would be slight changes in sediment deposition rates and sediment transport in the project area and downstream. Mitigation measures, if required, would be successful.

Moderate: The effect on the channel morphology would be readily apparent and would result in a notable change in either surface water or groundwater hydrology of the area. Flows or other hydrologic characteristics would be outside of the range of natural variability. However, while changes to flows would be readily apparent, hydrologic characteristics would remain within all hydrologic or channel morphology limits established by restoration design criteria. There would be notable changes in sediment deposition rates and sediment transport in the project area and downstream. Mitigation would probably be necessary to offset adverse effects and would likely be successful.

Major: Changes to surface water or groundwater hydrology or channel morphology would be severe or exceptional and would substantially alter stream channels or hydrology of the area. Flows would be outside of the range of natural variability, and could include a complete loss of water in some areas or unusual flooding in other areas. There would be substantial changes in sediment deposition rates and sediment transport in the project area and downstream. Extensive mitigation would be needed to offset adverse effects, and its success would not be assured.

Beneficial effects would retain hydrology and channel morphology within the range of natural variability or restore hydrologic and channel morphology conditions toward reference conditions.

Adverse effects would alter hydrologic and channel morphology conditions outside of the natural range of variability and further away from reference conditions.

Short-term: Effects would cease within three years following implementation of the action.

Long-term: Effects would extend more than three years beyond implementation of a restoration action.

IMPACTS OF ALTERNATIVE A – NO ACTION / CONTINUE CURRENT MANAGEMENT

Analysis

Water Quality. The no action alternative would not affect water quality conditions in zone 1 because this zone does not contain surface water or serve as the source of surface water for down-gradient locations.

Permanent surface flow begins at the upper end of zone 2 from the toe of a steeply eroded location where groundwater seeps and small springs emerge from the base of the vertical cut bank. Perennial flow continues uninterrupted down the length of Lulu Creek to its confluence with the Colorado River (approximately 2,200 linear feet to the confluence) and then further downstream to the Lulu City wetland (approximately 3,600 linear feet to the head of the wetland).

This perennial flow receives eroded soils and transports suspended materials and channel sediment bedload all year long but at different rates and quantities depending on rain and snow events. The greatest inputs of eroded materials and organic matter are received from the adjacent streambanks and floodplain in zones 2 and 3 during spring snowmelt. The quantities progressively increase downstream as additional inflows are received and as the volume of water and its velocity increases. These suspended sediments increase water turbidity, increase dissolved organic matter, and increase nutrients leached from the eroded mineral soil.

Turbidity and eroded materials are transported downstream during snowmelt runoff because there is little evidence of accumulated sediment deposits in the channel at this headwater area. Further downstream, these conditions change as water volumes increase with greater distance downstream and stream gradients decrease. Suspended sediment, sand, and bedload are deposited in stream and river reaches where lower velocities exist.

Under the no action alternative, water quality effects in Lulu Creek and the Colorado River below the confluence with Lulu Creek (zone 3) would be similar to those effects measured by Clow and Mast (2004) during the spring of 2004. Their investigation documented increased water turbidity, suspended solids (maximum of 5.5 mg/L), total nitrate nitrogen (maximum of 0.25 mg/L), dissolved organic carbon (4.5 mg/L), and total phosphorus (0.012 mg/L). The peak concentrations occurred during the highest flows associated with spring snowmelt in 2004 (Clow and Mast 2004). These water quality constituents would probably increase in concentration downstream as higher flows erode, transport, suspend, and dissolve the unconsolidated mineral and organic debris materials that line the creek channels and banks. However, none of these elevated concentrations exceeded or would be expected to exceed current water quality standards. There are no standards for suspended solids, turbidity, and dissolved organic carbon for this stream segment. The water quality standard for nitrate nitrogen used for domestic water supply is 10.0 mg/L. There are processes underway within the Colorado Water Quality Control Commission to establish a new, future total nitrogen standard to protect aquatic life. It is expected that current concentrations would not exceed the new standard.

Through time, the effects on water quality would vary in response to the snowmelt volume in the stream and the amount of debris eroded from the channel bed and the adjacent channelbanks. As new debris erodes, spikes in the concentration of these constituents plus others constituents associated with mineral soils would be expected to surge during the runoff period and then decline. Clow and Mast (2004) also demonstrated that suspended sediment concentrations in the Colorado River above Lulu Creek were higher than the concentrations in Lulu Creek, which illustrates that there are high background levels of suspended sediments during snowmelt runoff. The spikes in these water quality constituents would probably be greater than the normal range of variability under higher flow conditions because the quantity of highly erodible material derived from the breach would normally not be present in the impacted creek and river channels and floodplains.

The streams and wetland status as outstanding waters, which allows no degradation of existing water quality, would be jeopardized under the no action alternative because although the variations in the water constituents of concern (turbidity, suspended sediments, nitrogen, and phosphorus) would probably remain within the range of natural variation in each drainage, transport of suspended debris would adversely affect the designated use of cold water aquatic life. This water quality change would likely meet the significant degradation threshold established by the Colorado Department of Public Health and Environment (2010b) and would be considered a major long-term adverse impact on water quality.

Water quality in the Lulu City wetland would not be expected to substantially change with the no action alternative. However, there are no water quality monitoring data in or immediately downstream of the wetland available to support this evaluation. Based on the research of Nelson et al. (2011) on the influence of Colorado slope wetlands and headwater streams on water quality, it is expected that water quality would reflect the basic chemistry of the bedrock geology of the site. Wetland porewater would be expected to reflect a lower pH and higher concentrations of dissolved organic carbon, nitrogen, and several other ions than stream water (Nelson et al. 2011). The wetland would continue to provide the moderate beneficial water quality function of sediment filtering and retention but probably not to the extent that would have occurred before the 2003 ditch breach because some of the sediment retention areas of the wetland were buried. Sediment retention is a recognized important function of sedge and other types of wetlands that possess dense vegetation cover and shallow water depths. Sediment retention by the wetland improves downstream water quality by reducing suspended sediments and the nutrients and trace metals that are associated with the suspended inorganic and organic particles (USACE 1994; Kadlec and Wallace 2008). The extent of the sediment retention is illustrated by the time series photographs of the wetland, including its sediment deposition locations and patterns presented in chapter 3.

Some suspended sediment would be expected to pass through the wetland and continue downstream along the Colorado River toward Shadow Mountain Lake during the annual snowmelt runoff period. Increased quantities of suspended sediment would be transported through the wetland with higher runoff discharge and increases would be most likely during high runoff years such as 2010 and 2011. The long distance (more than 27 river miles) between the Lulu City wetland and the lake, the low stream gradient, and the filtering effects of intervening wetlands throughout the Kawuneeche Valley would help reduce suspended sediment and turbidity concentrations before they reach Shadow Mountain Lake. All these conditions collectively encourage the deposition of transported sediments, although it is possible that some suspended sediment and turbidity from the proposed restoration area may reach the lake. Additionally, other potential natural and anthropogenic point and non-point sources of suspended sediments and turbidity located downstream of the proposed restoration area could also contribute to river discharges into the lake. The limited suspended sediment information recorded at the Baker Gulch gaging station show concentrations ranging from 0 to 217 mg/L based on 63 measurements, with a mean of 11 mg/L.

Water quality data from the U.S. Geological Survey's Baker Gulch monitoring station are very limited after 2003 and none of them suggest substantially elevated concentrations of the water quality constituents of interest associated with the breach. The most comprehensive data set that can be used to establish water quality conditions through time is reported for January 1995 to September 1998 (U.S. Geological Survey 2011). Comparable data are, however, too limited after 1998 to establish any water parameter trends except for pH and specific conductance. For specific conductance, there is no noticeable difference in conditions before and after the 2003 breach. There is a possible slight increase in water pH from pre- to post-breach conditions although the number of post-breach data points (collected in 2010 and 2011) is low enough that this cannot be confirmed statistically. The consequences of decreasing water velocity in the wetland is the deposition of suspended sediments and bedload in the north portion of the wetland, which helps decrease suspended sediment loads in the river downstream of the wetland. This deposition causes the formation of sand and gravel bars and the rerouting of channels throughout the wetland, especially in the northern 30% to 50% of the wetland.

Based on these considerations, the no action alternative would have major, adverse impacts on water quality, principally because the increases in some water quality constituents (primarily suspended sediments and the nutrients associated with the sediments) during peak runoff periods would occur outside the normal range of variability. The consequences of sediment transport and deposition on stream channel morphology are discussed in the following sections.

Hydrology and Stream Channel Morphology. Future effects of the no action alternative to hydrology and stream channel morphology can best be appreciated by comparing the changes in the different areas today to conditions that existed immediately after the breach. Conditions have changed since the breach occurred in May 2003. High spring snowmelt runoff in the springs of 2010 and 2011 imposed the most severe hydrologic conditions on the streams and wetlands since the breach. Both the 2003 breach and the heavy runoff in 2011 resulted in overbank flow (Rathburn et al. 2011) along the Colorado River and Lulu Creek.

Hydrologically, there would be no effects on hydrology or channel morphology in zone 1 because it does not support surface water and would not be expected to do so in the future. Snowmelt and rain rapidly infiltrate into the coarse soils and become groundwater.

Zone 2, which is approximately 2,200 linear feet long, supports a shallow, narrow perennial stream 2 to 3 feet wide that begins from springs and seeps at the toe of a sharp grade drop in the eroded gully of the breach corridor and continues down a steep gradient of 15% to 20% to join Lulu Creek. Lulu Creek downstream of the breach confluence is a steep-gradient, rock-filled channel, with step-pool morphology that was extensively scoured by the surge of water from the Grand Ditch breach. Natural peak and seasonal base flows in Lulu Creek are influenced substantially by the operation of the Grand Ditch, which intercepts flows annually during the spring and summer months. Approximately 20,000 acre feet of water are diverted from it and 13 other streams in the watershed by this transbasin water diversion system. The Grand Ditch intersects the Lulu Creek watershed, with about 80% of the Lulu Creek drainage above Grand Ditch, and 20% below (Anderson and Rathburn, no date).

Channel dimensions and character have changed in Lulu Creek since the breach occurred (Rathburn et al. 2011). On Lulu Creek, snowmelt runoff flow is becoming concentrated in a single thread, with boulder steps forming and in some locations, instream wood is becoming incorporated into steps as ramps or width-spanning bridge pieces. Along the Colorado River, channel planform changes include an increase in single-thread, straight or meandering geometries, with persistent braided reaches where mid channel and lateral bar deposition results in elevated regions at bar tails. Flow-induced removal of logjams has occurred in certain reaches, releasing sediment stored on the upstream side, which facilitated the development of widely spaced steps of instream wood downstream.

High snowmelt flows in 2010 (a 30-year flow recurrence interval) and 2011 (an estimated 60-year flow recurrence interval) caused the flow to overtop the channelbanks (overbank flow), moved large quantities of debris downstream, caused the single thread channel to move laterally across the channel bottom, and created step-pool sequences on about a 12 to 15-foot interval. A majority of the steps have been formed of small to medium-sized boulders and some woody material. The channel slope has reached a relatively stable grade and is unlikely to incise further.

Mean daily Lulu Creek discharge in 2010 was 112 cubic feet/second, which resulted in substantial channel scouring, bank sloughing, lateral migration of Lulu Creek within the depositional fan, and a localized release of sediment stores to downstream reaches. Repeated cross sectional surveys across the fan at Lulu Creek indicate preferential erosion of the 2003 debris flow sediment relative to volumes removed from reaches on the Colorado River. Bed armoring of Lulu Creek was stabilizing channel incision except under the highest flows (Rathburn 2011a).

Primary channel morphologic changes along Lulu Creek since 2003 include return to a single-channel planform (stream shape as seen from a map or aerial view) with the channel grade intermittently occupied by steps formed of boulders and wood. The step-pools reduce the grade of the channel, water velocity, and erosion or scouring energy of the stream.

The debris and sediment eroded or scoured from the Lulu Creek channel and more importantly, the alluvial fan at the confluence of Lulu Creek and the Colorado River, has been transported into the full length of the Colorado River channel to the Lulu City wetland. The higher the snowmelt runoff, the more debris is eroded from the fan and transported. The 2011 snowmelt eroded new channels through the alluvial fan, filled the former active channel, and relocated the Colorado River into a new channel. In addition, new debris deposits were created along the riverbanks as much as 5 feet deep and 10 to 15 feet wide immediately downstream of the confluence. These deposits are unstable and exposed to erosion and transport by future flow events (figure 4.1).

Major transport of debris in zone 3 would continue annually through bedload and suspended sediment movement. Debris deposits already in the river channel and floodplain would continue to be reshaped to increase deposit quantities in some sections and to decrease deposit quantities in other sections to move the deposits slowly downstream into the Lulu City wetland. These changes affect channel location, capacity, stability, grade, and width and are symptomatic of an unstable river channel (Rathburn 2011a). Past debris flows created low berms between the river channel and low-lying floodplain areas east of the river and north of the Lulu City wetland. These berms inhibit overbank flooding of the floodplain and the loss of potential floodflow storage areas and groundwater infiltration areas.

Debris transported by the Colorado River into the Lulu City wetland would continue to settle out as gravel and sand bars as water velocity decreased. The degree and location of deposition would be determined by the magnitude of the runoff and the amount of debris that is suspended in or mobilized by the water. Sand and gravel bars not only relocate the water channels through the wetland, but they also bury existing wetland vegetation.

This alternative would not change the inflow of surface waters from the Colorado River into most of the wetland during spring runoff and early summer months. The extent, depth, and duration of the flooding would be determined by quantity and speed of the runoff. Based on the work of Spence et al. (2011) in boreal headwater wetlands, the Lulu City wetland would also continue to perform three hydrologic functions: initial snowmelt water storage early in spring; transmission of surface water inputs from the Colorado River through the wetland; and contribution of internally stored water to the Colorado River during late summer and early fall low flow periods.

The surface water distribution patterns in the wetland would continue to be affected by the deposition of transported sand, gravel, and sediment from debris sources upstream. The distribution patterns and main flow paths through the wetland would continue to shift as debris was redistributed by the scouring power of spring snowmelt or larger flow events. Most deposition would continue to occur in the northern 30% of the wetland where the water velocity first begins to dramatically decrease. Opportunistic observations of the north wetland area in August 2011 suggested that relative to June 2010 conditions in the same general area, most of the surface flow seemed to be directed to the east and central portion of the wetland rather than to the river channel on the west side of the wetland. Such annual changes in channel number, shape, direction, depth, and other morphological characteristics would continue to occur in the future as debris from the Colorado River (zone 3) was transported into the wetland. There is insufficient information available to understand the effects of annual debris deposition on groundwater distribution patterns.

Based on these considerations, the no action alternative would have major adverse impacts on surface water hydrology and stream channel morphology in Lulu Creek, the Colorado River between Lulu Creek confluence and the south end of the Lulu City wetland, and the Lulu City wetland. Insufficient groundwater hydrology information is available to determine impacts on groundwater in the Lulu City wetland. Major adverse impacts would occur because of severe changes to stream channel morphology and substantial changes in stream hydrology in some of the stream reaches, and surface water flows would be outside the natural range of variability for the pre-breach stream channels. There are few indications that substantial changes have occurred to the Colorado River channel morphology or hydrology downstream of the Lulu City wetland. Therefore, impacts downstream of the Lulu City wetland would be negligible to minor.

Cumulative Impacts

There are two other potentially important sources of impacts on water resources in the project area. The first impact source is continued operation of the Grand Ditch water diversions and debris from prior human-caused debris flows. The second is natural events in the Colorado River and Lulu Creek watersheds above the breach-impacted area. Operation of the Grand Ditch affects water volume and other hydrologic parameters of both the creek and the river. Previous human-caused debris flows have resulted in additional debris sources within the northern portion of the Kawuneeche Valley. Natural events in the upper watersheds can affect suspended sediment concentrations, other water quality characteristics, and hydrologic characteristics in both the creek and the river.

Under no action, breach-related debris and sediment eroded during spring snowmelt in both the creek and the river can equal or greatly exceed the quantity of this material that is transported by natural processes into the river from the watershed upgradient of breach affected areas. Field evidence from two recent spring runoff periods (2010 and 2011) document that the incremental contribution from the breach deposits in Lulu Creek and the Colorado River can cause major cumulative adverse effects on suspended sediments, stream channel morphology and surface water hydrology of these systems. These effects extend downstream about 3,500 linear feet into the Lulu City wetland. Hydrologically, changes in stream channel morphology caused by annual debris accumulation and erosion in the river channel combined with channel flow reductions caused by Grand Ditch diversions contribute to a major adverse cumulative effect on Colorado River channel stability below the Lulu Creek confluence. The annual discharge of 2003 sediments and debris into the north end of the Lulu City wetland added to the accumulated debris from previous events creates a major adverse cumulative impact on wetland surface water hydrology and stream channel morphology.

Conclusion

The no action alternative would have major, adverse impacts on water quality because the increases in some water quality constituents during peak runoff periods would likely occur outside the normal range of variability. This alternative would have major adverse impacts on surface water hydrology and stream channel morphology in Lulu Creek, the Colorado River, and the Lulu City wetland. The Lulu City wetland would continue to provide a moderate beneficial sediment retention water quality function, although its sediment retention function would be reduced compared to pre-breach conditions because some wetland treatment areas would remain buried under sediment. Insufficient groundwater hydrology information is available to determine impacts on groundwater in the Lulu City wetland. Changes in stream channel morphology caused by annual debris accumulation and erosion in the river channel combined with channel flow reductions caused by Grand Ditch diversions contribute to a major adverse cumulative effect on Colorado River channel stability below the Lulu Creek confluence. Annual debris deposits in the Lulu City wetland cause major adverse cumulative effects on wetland surface water hydrology and stream channel morphology.

IMPACTS OF ALTERNATIVE B – MINIMAL RESTORATION

Analysis

Water Quality. Alternative B would not affect water quality conditions in zone 1 because this zone does not contain surface water or serve as the source of surface water for down-gradient locations.

Alternative B would involve manual labor in limited areas to create stable slopes, reduce the potential for steep sediment deposits to collapse into the creek or river, and restore streambank vegetation that could reduce the potential for excessive bank erosion along the creek, river channels, and the Lulu City wetland in zones 2, 3, and 4, respectively. Unstable debris deposits would be excavated, recontoured, or protected with boulders and other rock materials to protect sediment deposition sites that are thought to be highly erodible from high flows in the stream or river. These temporary restoration activities could generate water turbidity and suspended sediments from channelbanks next to the stream or in the wetland. These changes would be temporary and restricted to small stretches of the channel or small areas in the wetland. Therefore, these adverse water quality effects would be short-term, minor, and well within the tolerance range of these aquatic systems. Spring snowmelt turbidity conditions would create much higher turbidity and suspended sediment conditions than the restoration effects of this alternative. Mitigation measures, such as keeping earth and other materials out of the stream or flooded wetland areas, would further minimize temporary adverse effects. A list of mitigation measures is provided in chapter 2.

Once restoration was completed, the erosion potential of the stabilized and protected debris deposits would be substantially reduced. It was estimated that approximately 25% of the 2003 debris deposits along Lulu Creek and 5% of the deposits along the Colorado River were most in need of protective measures. These sites represented locations with the highest potential for eroding and slumping into the water. Reducing these sources of continued turbidity, suspended sediments, and bedload materials to Lulu Creek, the Colorado River, and the Lulu City wetland would be a long-term, minor beneficial water quality impact of this restoration alternative. Water quality and aquatic habitat would improve because of the decreased contribution of debris and suspended sediments to the Colorado River and the Lulu City wetland, both of which support aquatic life communities.

For the same reasons that were discussed in alternative A, the Lulu City wetland would continue to provide long-term, moderate beneficial sediment filtering and retention water quality functions, although its sediment retention function would be reduced compared to pre-breach conditions because some wetland treatment areas would remain buried under sediment. Suspended sediment concentration and associated nutrients and trace metals would be reduced in the Colorado River downstream of the wetland.

Hydrology and Stream Channel Morphology. Alternative B would involve modifying a total of about 1,500 linear feet of banks outside the channel, but would not cause any hydrologic impacts because none of the restoration actions would directly involve altering water flows or water quantities. Also, none of its proposed actions would change stream channel numbers, locations, or morphology. However, the hydrology and stream channel morphology effects currently occurring under existing environmental conditions would continue the adverse impacts of transporting eroded bedload and suspended sediment downstream from the source deposits in the floodplains and channels of Lulu Creek and the Colorado River. The effects of alternative B relative to alternative A on hydrology and stream channel morphology would be negligible. Consequently, for the reasons that were described for alternative A, major long-term adverse impacts on surface water hydrology and stream channel morphology would continue.

Cumulative Impacts

Very similar cumulative impacts would result from alternative B as those described for alternative A, except that the intensity (magnitude) of adverse impacts on water quality would be somewhat less with alternative B because of the minor beneficial effects of removing and protecting the most erosion-prone debris locations from contact with high streamflows. Similar major adverse cumulative impacts on stream channel morphology and hydrology would occur with alternative B because the same hydrologic and unstable stream channel morphology conditions would continue to exist after the restoration actions were completed. Cumulative water quality conditions would continue to be adversely affected by the erosion of unprotected debris deposits in the Lulu Creek and Colorado River floodplains during higher than normal snowmelt runoff events.

Conclusion

Short-term, adverse water quality changes resulting from restoration measures would be minor and none of the regulated water quality constituents would exceed water quality standards. Restoration measures would produce long-term, minor, beneficial water quality impacts. Long-term, major adverse impacts on surface water hydrology and stream channel morphology would continue. These same streamflow and stream channel morphology conditions would contribute to long-term, adverse, cumulative impacts in Lulu Creek, the Colorado River, and the Lulu City wetland. The Lulu City wetland would continue to provide long-term, moderate, beneficial sediment and nutrient filtering and retention water quality functions, although its sediment retention function would be reduced compared to pre-breach conditions because some wetland treatment areas would remain buried under sediment.

IMPACTS OF ALTERNATIVE C – HIGH RESTORATION

Analysis

Water Quality. Alternative C would not affect water quality conditions in zone 1 because this zone does not contain surface water or serve as the source of surface water for down-gradient locations.

Alternative C would involve a combination of manual labor and mechanical equipment working more extensive areas of debris deposits to create stable slopes and erosion-resistant bank conditions along the creek, river channels, and the Lulu City wetland in zones 2, 3, and 4, respectively.

The following restoration actions would have water quality effects. The amount of streamside debris deposition that would be protected from erosion would be substantially increased over alternative B in both Lulu Creek and the Colorado River. Channel grade improvements (e.g., step pools) would be installed to reduce water velocity and energy in the creek and the river. About 16,300 cubic yards of accumulated debris would be removed from the Lulu City wetland. Stream channels within the Lulu City wetland would be altered to direct the primary surface water flows to the historical Colorado River channel near the center of the wetland. A river floodplain area in zone 3 would be hydrologically reconnected to the river during high snowmelt periods. Restoration activities would require up to three years of working during snow-free and low-water conditions. The best management practices described in chapter 2 and others identified during later design phases would be applied to alternative C.

In zones 2 and 3, approximately 1,000 and 200 linear feet of channelbank would be stabilized and protected from water erosion along Lulu Creek and the Colorado River, respectively. These quantities represent about 60% and 30% of the creek and riverbank lengths, respectively with severe to moderate debris erosion potential. Approximately 22 and 10 step-pools would either be installed or enlarged in Lulu Creek and Colorado River, respectively.

Bank restoration, step-pool installation, confining Lulu Creek to a single channel in the alluvial debris fan at its downstream end, and removing a 20-foot-wide bank of alluvial fan debris from the restored Lulu Creek edge would require activities occurring in the water. Suspended sediment and water turbidity production would have short-term, moderate, adverse impacts. Best management practices would be employed to confine these changes to the restoration sites and to minimize the magnitude of the impacts on downstream water quality. These best management practices have been demonstrated to be efficient and effective when installed and maintained properly. Earth-working and debris and sediment management activities, particularly in the wetland, could release dissolved nutrients (primarily nitrates and phosphates) into the surface water and temporarily increase their concentrations there. (A similar phenomenon occurs naturally with the overland flow of snowmelt each spring.) These nutrients should not directly harm aquatic life; however, the nitrate concentration could temporarily rise above the 10 mg/L standard set to protect drinking water supply uses. These increases would be difficult to contain with conventional best management practices. This condition would be considered a major, short-term, adverse water quality impact. There are processes underway within the Colorado Water Quality Control Commission to establish a new, future total nitrogen standard to protect aquatic life. The National Park Service would take aggressive design and restoration measures to attempt to comply with a future aquatic life standard for total nitrogen when one is promulgated.

During restoration, increases in existing water constituents would also conflict with the antidegradation requirement of the Outstanding Waters designation for surface waters in the project area. However, because the degradation would be a temporary condition, a waiver may be issued allowing the activity to occur. Under these conditions, water quality changes during restoration may be considered a short-term, minor to moderate adverse impact.

Following restoration, the actions would improve long-term water quality conditions by reducing the quantity and frequency of sediment entering the river and creek channels. These changes would be considered long-term, major, beneficial water quality improvements. Restoring peak snowmelt runoff discharges into the cut-off floodplain area in the lower portion of zone 3 would also provide a long-term, moderate, beneficial water quality improvement by encouraging suspended sediment retention and deposition and gradual release of floodwaters to downstream areas.

Because none of the debris already in zone 3 (below the Lulu Creek and Colorado River confluence) would be excavated and portions of the alluvial fan in zone 2 would remain, debris bedload already in the creek and river channels and floodplains would remain available for downstream transport into the Lulu City wetland when runoff flows are strong enough to mobilize this material. Annual downstream movement of this material is being monitored (Rathburn 2011b). Lighter suspended sediments, sand, and gravels would continue to be transported into the Lulu City wetland each year. Downstream movement of material would continue for years with the rate being dependent upon the magnitude of runoff events. This material transport and deposition in the wetland would be considered a long-term, adverse, water quality impact on cold water aquatic life use and the Outstanding Waters status of the wetland.

Some water quality impacts in the Lulu City wetland (zone 4) would be substantially different from those of the Lulu Creek and the Colorado River upstream of the wetland. Excavating approximately 16,300 cubic yards (about 12.0 acres) of 2003 debris (or approximate equivalent) from the wetland and excavating or filling about 4,600 linear feet of new and historical river channels in the wetland would affect both surface and groundwater. Debris excavation and removal would be expected to generate substantial quantities of suspended sediment, organic solids, dissolved organic matter, and nutrients above existing water quality conditions in the wetland.

These materials would result in increased surface water turbidity and dissolved nutrient (dissolved forms of nitrogen and phosphorus) releases during restoration. Disturbing buried mineral and organic soils (possibly including limited area of peat lenses) would be expected to increase surface water nitrogen concentrations above the water quality standard for drinking water and above the antidegradation standard for Outstanding Waters. Water levels in the wetland may have to be lowered to accommodate restoration activities. Changing water levels and soil moistures during restoration can change the nitrogen retention and release dynamics of the wetland soils. Concentrations of inorganic forms of nitrogen are related to the moisture-aeration regime of the substrate. High ammonia-nitrogen and nitrate-nitrogen concentrations in aerated soil zones would be created by water level fluctuations and exposure of excavated organic soils to the air. These changes would lead to higher rates of organic nitrogen mineralization and oxidation (Richardson et al. 1978). In addition, nitrate nitrogen concentrations may increase during periods of low water because denitrification is inhibited in aerobic conditions.

Pinay et al. (2002) examined the relative roles of changing hydrologic regimes in streams and riparian wetlands in the nitrogen cycle. Riparian wetlands played an important and relatively larger role in the nitrogen cycle than streams; especially the smaller headwater streams, such as those in the project area. It was concluded that riparian wetlands are important storage components for nitrogen and that exposing organic nitrogen in wetland soils to oxygen results in the formation of nitrate nitrogen. Changes to the water regime, either through alterations in the frequency, duration, period of occurrence, and intensity of water levels, directly affect nitrogen cycling in alluvial soils by controlling the duration of aerobic and anaerobic phases. Therefore the end products of nitrogen cycling in riparian wetland soils are under the control of the moisture regime including the groundwater table for example, with important implications for wetland nitrogen retention or leaching processes. High nitrate levels peak during spring thaw because cold temperatures limit both denitrification and plant uptake during the winter.

Klopatek (1978) reported that drainage of wetland soils in Wisconsin markedly disrupted the nitrogen balance of a marsh due to more rapid decomposition of organic matter and resultant release of large quantities of soluble organic nitrogen and nitrate nitrogen. Nitrate nitrogen levels in the exposed soils during June and July were more than 100 mg/L in some locations. The elevated nitrate nitrogen concentration changes decreased one to two years after the wetland was reflooded.

Manninen (1998) demonstrated that excavations (ditching) in cold forest settings produced surface water concentration increases in monitored streams of total solids (four to six times greater), total nitrogen (two to four times greater), phosphorus(one to two times greater) than a comparison reference stream. Nitrate nitrogen remained about four times higher in the disturbed stream than the control stream for at least two years after the disturbance occurred. Nitrogen leaching peaked during snowmelt runoff.

Given these findings and the presence of high organic matter in the Lulu City wetland, it would be anticipated that debris removal actions in the wetland would produce substantial increases in the concentrations of nitrogen, especially nitrates, as well as suspended sediments, turbidity, phosphorus, trace metals, and dissolved organic matter. Changes in water pH would also be expected with oxygen changes in the disturbed wetland soils and the mobilization of organic matter. Because nitrogen retention and leaching processes of wetland soils are tied closely to groundwater and surface water conditions (Pinay et al. 2002), there is a high potential that effects on the nitrogen cycling process may extend beyond the limits of the excavation activities in the wetland. Potential changes to the groundwater hydrology conditions of the wetland are discussed in the next section.

Extensive best management practices would be employed to control and minimize turbidity and suspended sediment releases. These practices are proven effective for these water constituents. However, the dissolved nutrients, organic matter, and trace metals would not be controlled as effectively as suspended particulates for the following reasons.

The fate of nitrogen and its multiple chemical forms in wetlands and streams is a complex process that is affected by many physical, chemical, and biological processes. Elevated nitrate releases could persist for the duration of the wetland restoration period and for several years after restoration because the organic content of wetland soils left in place would be exposed to potentially higher aerobic soil conditions when the groundwater table is lowered to accommodate willow restoration. Very few studies of these conditions have been reported in the literature. Byron and Goldman (1989), who examined the relationships between watershed land use disturbances in high- and low-erosion areas and resulting nitrogen and phosphorus water quality, noted it took at least 10 years for elevated stream nitrate-nitrogen concentrations to return to near-typical concentrations after disturbances from logging and stream gravel mining in subwatersheds in the Lake Tahoe area. Lexa (2005) studied the effects of installing drainage tiles in a saturated wetland area to decrease the groundwater table on water nitrate-nitrogen concentrations. That investigation revealed it required about 8 years for elevated nitrate-nitrogen concentrations (ranging from about 18 to 22 mg/L nitrate-nitrogen) to stabilize at about 14 mg/L nitrate-nitrogen. Increased nitrate-nitrogen concentrations were attributed to the mineralization of soil organic matter in the aerobic soil zone above the lowered groundwater table. The quantity of nitrate-nitrogen discharges from the Lulu City wetland would be contingent on the quantity of organic material that would remain in the wetland substrate that becomes aerobic after the groundwater table is reduced to accommodate development of tall willow community and the length of time required to oxidize the residual peat or soil organic matter in the restored area.

Releases of elevated nitrate-nitrogen to the Colorado River from wetland sediment removal activities would involve another set of chemical and biological transformation processes that would affect the duration and quantity of potential elevated nitrate-nitrogen concentrations downstream from the restoration area. Based on the investigations of Sebetich et al. (1984) that evaluated the fate and absorption of introduced nitrate-nitrogen and phosphate-phosphorus pulses into a mountain stream in Redwood National Park, it would be expected that nitrate-nitrogen would be rapidly dispersed and/or assimilated (removed from the water) by aquatic periphyton and other stream biota as long as the nitrate concentrations remained lower than biological demands. As the biological demands for these nutrients decreased, the removal efficiency of the stream biota would decline and the nitrate-nitrogen would extend further downstream.

The distance and duration of elevated nitrate concentrations following restoration are unknown at this time. The intensity and distribution of this impact would depend on the quantity and timing of nitrate releases from the wetland area, the time of year, wetland groundwater dynamics, the dilution effect of downstream tributary inflows, and the quantity and species composition of aquatic biota present in the Colorado River to assimilate nitrate-nitrogen. “Aquatic biota,” as used here, also includes stream-dependent plant life such as all the riparian and wetland (e.g., Shipler Park) vegetation in this section of the Colorado River.

The findings from the literature noted above are from situations somewhat similar to the restoration activities that will occur under the NPS preferred alternative; however, significant differences remain. This makes an extrapolation of those conditions and results to these restoration activities imperfect and only partially applicable. Nonetheless, impacts to water quality must be predicted, and a conservative approach has been taken here. Therefore, it is concluded that water quality changes during restoration activities that increase nitrate concentrations above long-term background levels would be considered to have a major, short-term, adverse impact and a major long-term adverse impact on water quality.

Excavating the 2003 debris from the wetland would have long-term, major benefits in removing potential sources of sediments that could be transported further into the wetland and the Colorado River channel. This excavation would create storage space for retention of future sediment bedload that is still moving downstream through the system.

Hydrology and Stream Channel Morphology. Alternative C would modify a total of about 7,400 linear feet of banks and stream channels to protect banks and to decrease channel scour. It would modify the existing Lulu Creek and Colorado River channels to decrease water velocity, lateral movements of the channels, and bank scouring. Substantial channel changes would occur to the Colorado River passing through the Lulu City wetland.

Alternative C would retain the existing surface water hydrologic regime in Lulu Creek and the Colorado River. Changes to reduce the water velocity and its debris scouring energy in both systems would include installing new, or enhancing existing step-pools. These step-pools would consist of both rock and wood materials. These changes would effectively reduce the average grade of the channels, which would decrease water velocity and the amount of channel and bank scour of debris materials. Combined with the installation of streamside rock protection of the adjacent debris banks, bank erosion would be substantially reduced. Down-cutting of the channel would be decreased or avoided with reduced water velocity.

Based on the work of Anderson and Rathburn (no date) and Rathburn et al. (2011), the design of the restored channel dimensions for Lulu Creek and the Colorado River would be based on an overbank flooding recurrence interval of 1 to 2 years. Thus, channels will be designed with shape, slope, and streambank conditions that convey the channel flow so it overtops its banks without eroding every 1 to 2 years on the average. Designing for this class of runoff event allows the channels to convey all snowmelt runoff and storm events and remain stable in most years. Typical Lulu Creek top-of-channel widths would range from 8 to 16 feet. Typical Colorado River top-of-channel widths would range from 17 to 20 feet above its confluence with the Lulu City wetland (zone 3) and could accommodate flow of approximately 740 cubic feet per second (Anderson and Rathburn, no date). An average depth would be about 2 feet for Lulu Creek and 3 feet for the Colorado River. However, final channel width and depth would be determined by additional hydrologic, hydraulic and engineering modeling. These changes would result in long-term, moderate, beneficial impacts on hydrology and stream channel morphology for both Lulu Creek and the Colorado River. Average Colorado River channel top of bank width would range from 20 to 31 feet through Lulu City wetland (see table 2.3).

The downstream section of Lulu Creek that crosses the debris alluvial fan would have additional channel stabilization and erosion protection designed to prevent overbank flooding from eroding materials. The design would begin an estimated 15 to 20 feet from the edge of the channel. This additional measure would help retain the creek's flow to its channel during higher runoff events and would substantially reduce the risk of chronic debris erosion from the alluvial fan with its subsequent transport downstream. These changes would also result in long-term major beneficial impacts on hydrology and stream channel morphology for both Lulu Creek and the Colorado River.

Lulu City wetland would experience substantial changes in hydrology and stream channel morphology resulting from the following items described in detail below:

- Restoring the principal Colorado River flow to the center of the wetland (referred to as the historical channel alignment);
- Lowering the wetland surface in the northern portion of the wetland to restore pre-2003 wetland surface elevations by removing 2003 debris deposits (or approximate equivalent volume); and
- Filling existing river channels or braids on the west side of the wetland.

Deposits of the 2003 debris materials range from about 4 to 36 inches thick in the wetland (Potter 2010b). Debris thickness decreases downstream through the wetland, meaning the thickest debris deposits are at the north end of the wetland. With two exceptions where deposits filled the historical river channel, all debris deposits occur west of the historical river channel. For impact evaluation purposes, it was assumed an average depth of 24 inches of 2003 material would be removed over 12 acres of wetland for this alternative. To protect fen wetlands located east of the historical river channel from potential restoration effects, all restoration activities would be kept west of the historical river channel to the greatest extent possible. Debris deposits and Colorado River channel conditions in the wetland in August 2011 are illustrated in figure 4.1.

The current understanding of surface and groundwater hydrology of the Lulu City wetland is based on field observations and investigations in the wetland since 2003 (Cooper 2007b; Cooper 2007c; Cooper 2009; Cooper and Potter 2009; Cooper and Potter 2010; and Rubin 2010). Colorado River surface water flows and sediment transport into the wetland can be inferred from Woods (2000 and 2001) and Rathburn (2009, 2010, and 2011a).

The water supply for headwater wetlands like the Lulu City wetland comes from a combination of four surface and groundwater sources: direct snowmelt and rain fall, surface water inflow from the Colorado River, subsurface groundwater inflow from areas upgradient of the wetland (most likely the Colorado River in this case), and groundwater inflow from the adjacent mountain slopes (Ruddy and Williams 1991, Woods 2000). The relative contribution and hydrologic importance of each source in maintaining a large wetland complex like the Lulu City wetland depends on many site-specific and temporal variables that can become complex to understand and restore.

Debris deposit at north end of the Lulu City wetland that would be removed. Facing downstream with west side channel of Colorado River to the right and the central Colorado River channel flow to the left.

Debris deposit at north end of the Lulu City wetland that would be removed. Facing downstream along the existing west side channel of Colorado River.

Portion of the historical Colorado River channel in the center of the Lulu City wetland, facing downstream. This channel section occurs in the northern third of the wetland and would be expanded to carry the entire flow of the river through the wetland. Width is about 5 to 6 feet.

Portion of the west-side channel of the Colorado River in the central portion of the wetland, facing upstream. This portion of the channel would be blocked and filled to support tall willow community. Channel width is about 4 feet.

Figure 4.1: Hydrology and stream channel morphology conditions in Lulu City wetland in August 2011

For example, the Ruddy and Williams (1991) study of four subalpine wetlands in the Williams Fork drainage (west of Winter Park, Colorado), concluded that precipitation, snowmelt, side-slope flow, and groundwater inflows were major water sources affecting wetland hydrology. Groundwater flows were from wetland to stream in these systems. Streamflow could be a substantial source of recharge to groundwater in some wetlands. Stream overbank flow and stream recharge to wetland groundwater were uncommon and affected only a limited area near the stream. Decreases in stream stage due to diversion of main channel surface water flows may not affect all adjacent wetlands uniformly and consistently. In June, stream elevation and wetland groundwater levels were a function of snowmelt. By September, stream elevation declined and became a function of groundwater discharge and storm events, whereas groundwater levels were a function of accumulated evapotranspiration loss and decreased direct discharge. Seasonal decreases in wetland groundwater were not due to decreases in stream elevation. Mean monthly streamflows for two years reflected typical snowmelt runoff pattern, with peak streamflow occurring in June. More than 75% of total annual streamflow occurred during May, June, and July. Lowest streamflow occurred during January, February, and March.

A hydrologic investigation of groundwater and surface water relationships in subalpine wetlands in the Kawuneeche Valley near the Timber Creek campground in the park by Woods (2000 and 2001) revealed that the effect of the Colorado River surface water elevation (that is, stage) on water table levels decreased with increasing distance from the river, especially in narrow valleys sections and near beaver ponds and oxbows. Sideslope runoff was more important than the Colorado River for controlling water table levels in confined valley sections. Subsurface sideslope runoff generally became a more important factor controlling water table elevations as distance from the river increased (Woods 2000). The Colorado River was a gaining stream in most stretches of the river flowing through the wetlands, meaning that groundwater was generally flowing toward the river (Woods 2000). Changes in water table elevation were generally affected very little by changes in the river stage away from the river edge (about 60 feet) (Woods 2000). Exceptions did occur, with changes being recorded more than 600 feet away.

The strength of the relationship between river stage and water table levels varied, depending on the proximity of beaver ponds and oxbows and hydraulic conductivity of the soils in the floodplain, indicating that they may be sources of groundwater recharge. Furthermore, groundwater modeling indicated that the predominant direction of groundwater flow was as a broad, subsurface plume down-valley. The implications of the investigations of Ruddy and Williams (1991) and Woods (2000 and 2001) are that site-specific groundwater and surface water investigations and modeling of the Lulu City wetland and Colorado River will be required to understand how best to remove the deposited sediment to create suitable growing conditions for tall willow without causing excessive periods of standing water.

The water sources and the interactions among them described by these authors are present in the Lulu City wetland. In a typical year, the Lulu City wetland has snow cover or standing surface water present over much of its surface until mid-June or mid-July, depending on the temperature. As temperatures warm, the wetland becomes flooded by direct snowmelt and by overbank flooding from the Colorado River and side-slope runoff. In 2011, the abundant snowmelt caused standing water to be present throughout much of the wetland into early September. During spring runoff, water flows across the wetland as sheetflow, especially in the north 30 to 40% of the wetland, and recharges groundwater. As the runoff quantity decreases, surface water begins following a complex of low swales, meanders, and the main Colorado River channels on the west and center of the wetland to the south (see aerial photograph time sequence presented previously in chapter 3). Generally, surface and groundwater elevations decline throughout the summer and winter to depths ranging from 20 to 40 inches below the ground surface. These changes in depth to groundwater elevations are important factors controlling the restoration of the ecological reference conditions.

Therefore, understanding the groundwater and surface waters interrelationships in the Lulu City wetland is essential for achieving successful restoration of the reference condition.

Final design of the Lulu City wetland would maintain the hydrologic relationships of the four water sources and their relative importance in achieving the desired reference wetland community. A full understanding of the relative importance of water sources to the surface and groundwater relationships of the Lulu City wetland would be needed before the final restoration design is completed. Final design would include any hydrologic modeling of the wetland or other investigations that would be needed to ensure development of a successful design and that would be used to determine:

- Specific locations and depths of debris excavation;
- Final wetland contours and grades; and
- Final widths and channel elevations for the Colorado River through the wetland.

For the current impact analysis, based on the existing groundwater information collected in the Lulu City wetland, it is presumed that final design and finish grading of the wetland would result in:

- Post-excavation groundwater depth and flow direction that would follow the recontoured wetland ground surface towards the relocated Colorado River channel; and
- Maintenance of groundwater depth relative to the new wetland surface that would be suitable to support reference condition vegetation.

Restoration actions would result in the routing of the braided Colorado River flows at the north end of the wetland into a single channel that would follow the historical river channel alignment similar to that shown in figure 3.6 for year 1937. To accommodate the restored flow, the channel would be widened along its entire length through the Lulu City wetland from the current 5 to 6 feet to approximately 20 to 31 feet with an average depth of about 3 feet. However, final channel width and depth would be determined by additional hydrologic, hydraulic, and engineering modeling. This estimated width is based on comparisons of the existing single channel width at river locations downstream of the Lulu City wetland. Channelbanks would be protected with willows and sedges to form the erosion-resistant bank cover that currently exists (figure 4.1). Temporary erosion protection measures may be needed until willows and sedges become well established. Directing surface water toward a central channel could decrease the sediment retention function of the wetland, reduce the residence time of surface water in the wetland, and reduce the storage of groundwater in the wetland for slow release during the late fall and winter months, as these effects are influenced by the surface water and groundwater interactions of the wetland.

After removing the debris deposits, the site would require final site grading to ensure that surface water and groundwater flows are directed in an east-west direction towards the re-located Colorado River channel. The existing west-side channel of the Colorado River would be plugged with rock and earth to discourage peak flows from continuing to follow this channel. The south portion of the west-side channel would be backfilled with excavated sediment and planted with willows downstream of the excavation zone. This action would discourage surface waters from continuing to follow the channel.

Presuming the assessment assumptions listed above are correct, the pre-breach wetland surface and groundwater hydrologic conditions would be restored. Final wetland ground elevations would be adequate to accommodate the development and maintenance of the post-excavation willow community. During restoration the fundamental hydrology of the northern 30 to 50% of the wetland would be changed from its current conditions to accommodate removing the 2003 sediment and to reshape the soil surface to accommodate the future hydrology pattern. This hydrology pattern would involve a groundwater table 1 to 2 feet below the ground surface in the willow communities during the late summer months, with most surface water in the wetland moving through a central river channel. These changes would create major short-term, adverse impacts on hydrology and stream channel morphology for up to three years while restoration was underway. Following restoration, these changes would have long-term benefits in returning surface and groundwater hydrologic, hydraulic, and stream channel morphology characteristics to presumably more natural ecological reference conditions that existed in 1937 (as illustrated in previous figures).

Some streamside sediment removal from the river floodplain in zone 3 would also restore former spring floodflow retention by wetlands that are currently partially prevented from providing this floodplain function. Because of the limited amount of sediment removal associated with this alternative, flooding of area M would be expected only during years with higher spring runoff conditions. This would be a moderate, long-term, beneficial impact on floodplain floodflow storage and discharge functions because the new flooding regime would probably be outside the range of variability of the existing hydrologic regime.

Cumulative Impacts

Debris deposits have accumulated in the north end of the Lulu City wetland and caused concurrent alterations of the Colorado River channel location and flow capacity for at least the last 58 years. Alternative C would remove a debris increment that is approximately equivalent to the estimated 2003 breach contribution. Restoring the site to pre-2003 hydrology and Colorado River channel morphologic conditions would have a long-term, major, beneficial cumulative impact by creating a wetland ground surface elevation and surface water and groundwater hydrology that probably existed before the 2003 breach occurred. Some streamside sediment removal from the river floodplain in zone 3 would also restore former spring floodflow retention and discharge by wetlands that are currently partially prevented from providing this beneficial floodplain function. This would be a long-term, moderate, beneficial impact.

Conclusion

Short-term, adverse water quality changes resulting from alternative C restoration measures would be major because nitrate-nitrogen concentrations, a regulated water quality constituent, would exceed water quality standards for both coldwater aquatic life and water supply uses. During construction, short-term, major, adverse impacts and major, long-term, adverse water quality impacts after construction may result from conflict with the antidegradation requirement of the Outstanding Waters standard. Following restoration, the actions would result in long-term, major, beneficial water quality improvements by removing much of the suspended sediment and sediment sources. Lulu Creek and Colorado River channel restoration would result in long-term, moderate, beneficial effects on surface hydrology and stream channel morphology. Major short-term adverse impacts on hydrology and stream channel morphology would occur in Lulu Creek, the Colorado River, and the Lulu City wetland during restoration periods. The Lulu City wetland may provide reduced long term, minor, beneficial sediment and nutrient filtering and retention water quality functions because of surface water hydrologic changes. Some streamside sediment removal from the river floodplain in zone 3 would also restore former spring floodflow retention and discharge by wetlands that are currently partially prevented from providing this beneficial floodplain function. This would be a long-term, moderate, beneficial impact.

IMPACTS OF ALTERNATIVE D – THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Analysis

Alternative D would also involve a combination of manual labor and mechanical equipment working more extensive areas of sediment deposits to create stable slopes, protect steep and erosion-prone deposits from collapsing into the creek, and establish vegetated streambanks along the creek, river channels, and the Lulu City wetland in zones 2, 3, and 4, respectively.

The following restoration actions would have water quality effects. The amount of streamside sediment deposits to be protected from erosion would be substantially increased over alternative C. Protection would involve relocating as much of the alluvial fan from the confluence of Lulu Creek and the Colorado River to an adjacent upland location as would be needed to establish a naturally stable, single-thread stream channel and adjacent floodplain and to protect the remaining alluvial material from erosion during high streamflow. These relocation actions would generate some turbidity and suspended sediments where activity was required in the stream channel. The best management practices described in chapter 2 (and others identified during later design phases) would be applied to alternative D.

A smaller quantity of about 12,000 cubic yards of accumulated 2003-derived debris (or approximate equivalent volume) would be removed from the Lulu City wetland. Stream channels within the Lulu City wetland would be altered to direct the primary surface water flows to the historical Colorado River channel near the center of the wetland. The same river wetland floodplain area in zone 3 would be hydrologically reconnected to the river during high snowmelt periods.

Key hydrologic differences with alternative D include excavating and routing the Colorado River channel upstream of the river's confluence with the Lulu City wetland; omitting step-pools in zones 2 and 3; and excavating only two, shorter reaches of the historical Colorado River channel in the Lulu City wetland. Reconnecting the river channel to the historical channel would require abandoning and blocking the current river channel below the diversion point. Restoration activities would require up to three years.

In zones 2 and 3, approximately 3,100 linear feet of channelbank would be protected from slumping into the stream and from water erosion along Lulu Creek and the Colorado River below the confluence where sediment from the alluvial fan was deposited during the spring 2011 runoff. Areas expected to need protection are at different locations along the channels. These locations have moderate to severe sediment erosion potential (see figure 4.2).

The alluvial fan would be protected from overbank flooding in Lulu Creek with rocks and boulders. The disposal site would be protected from peak runoff flood events.

Water Quality. Alternative D would not affect water quality conditions in zone 1 because this zone does not contain surface water or serve as the source of surface water for down-gradient locations.

Alternative D water quality impacts would be similar to those of alternative C. Although the locations of water quality impacts would be different between the two alternatives in some areas, the factors generating the effects and the processes responsible for adverse restoration impacts would be the same. The size of the area affected by alternative D would be smaller than in alternative C, but these actions would still generate changes that would be considered major, short-term and long-term adverse effects during restoration phases. Changes could be sufficient to exceed water quality standards for nitrates (both coldwater aquatic life and water supply uses) and suspended sediments.

Upstream end of alluvial fan on Lulu Creek, facing across creek. Deposit 4 to 5 feet thick.

Downstream end of alluvial fan deposit on Lulu Creek, facing upstream. Creek is in foreground.

Upstream end of alluvial deposits on Colorado River below confluence; facing downstream. Deposit thickness is 4 to 5 feet.

Downstream end of alluvial deposits on Colorado River below confluence; facing downstream. Deposit thickness is 4 to 5 feet.

Figure 4.2: Debris deposits in August 2011 in lower Lulu Creek and Colorado River at the confluence that would be removed with alternative D

These and other water constituents would exceed existing water quality conditions, thus conflict with the antidegradation requirement of the Outstanding Waters designation in Lulu Creek, the Colorado River, and the Lulu City wetland.

For the same reasons that were described for alternative C, long-term water quality conditions would experience a major beneficial improvement as restoration actions take effect. Nevertheless, debris deposits currently located in the Colorado River channel upstream of the Lulu City wetland would continue to move downstream creating a debris source for continued wetland sedimentation.

Hydrology and Stream Channel Morphology. Alternative D hydrology and stream channel morphology impacts would be similar to but less extensive than those of alternative C. Alternative D would modify banks and channel sides to protect sediment deposits from extensive slumping into the channels and eroding. Protection techniques would accommodate natural stream channel processes to maintain the dynamic relationships between the channel, its floodplain, and channel flow capacity. Although the locations of channel modifications and sediment excavations would be different between the two alternatives in some areas, the factors generating the effects and the processes responsible for adverse impacts would be the same. About 3,100 linear feet of channel modifications would occur with alternative D.

Sediment excavation in the northern section of the Lulu City wetland would affect about 4.1 acres and would remove an average thickness of 2 feet. Surface water would be routed to the historical Colorado River channel in the wetland using the same techniques that were described for alternative C. However, alternative D would excavate only two short sections of the channel that had been filled by sediment from the 2003 breach. The remaining Colorado River channel sections through the wetland would be left unaltered to accommodate the additional surface water.

Energy dissipating step-pools in lower Lulu Creek and the upper Colorado River in the alluvial fan deposition area would be created as necessary to help restore a stable channel after sediment was removed. Step-pools would be expected to migrate and reform in the channel in the highest runoff years as stream gradient and energy levels change in response to natural channel-forming processes. Natural step-pool formation would be relied upon to reduce channel grade and water velocity in Lulu Creek upstream and the Colorado River downstream of this area.

Assuming the assessment assumptions previously listed are correct, the pre-breach wetland surface and groundwater hydrologic conditions would be restored. Final wetland ground elevations would be adequate to accommodate the development and maintenance of the post-excavation willow community. During restoration the fundamental hydrology of the northern 30% of the wetland would be changed from current conditions to remove the 2003 sediment and to reshape the wetland surface to accommodate the future hydrology pattern. This hydrology pattern would involve a groundwater table 1 to 2 feet below the ground surface in the willow communities during the late summer months, with most surface water in the wetland moving through a central river channel. These changes would create major, short-term, adverse impacts on hydrology and stream channel morphology for up to three years during restoration. These changes would have long-term benefits in returning surface and groundwater hydrologic, hydraulic, and stream channel characteristics to presumably more natural ecological reference conditions that existed in 1937 (as illustrated in previous figures).

Some streamside sediment removal from the river floodplain in zone 3 would also restore former spring floodflow retention by wetlands that are currently partially prevented from providing this floodplain function. Because of the limited amount of sediment removal associated with this alternative, flooding would be expected only during years with higher spring runoff conditions. This would be a moderate, long-term, beneficial impact on floodplain floodflow storage and discharge functions because the new flooding regime would probably be outside the range of variability of the existing hydrologic regime.

Cumulative Impacts

Sediment deposits have accumulated in the north end of the Lulu City wetland and have caused concurrent alterations of the Colorado River channel location and flow capacity for at least the last 58 years. Alternative D would remove a quantity of sediment that is approximately equivalent to the estimated 2003 breach contribution. Restoring the site to pre-2003 hydrology and Colorado River channel morphology conditions would have a long-term, major, beneficial cumulative impact by creating a wetland ground surface elevation and surface water and groundwater hydrology that probably existed before the 2003 breach. Some streamside sediment removal from the river floodplain in zone 3 would also restore former spring floodflow retention by wetlands that are currently partially prevented from providing this beneficial floodplain function. This would be a long-term, moderate, beneficial impact.

Conclusion

Short-term and long-term, adverse water quality changes resulting from Alternative D implementation of the restoration measures would be major because nitrate-nitrogen concentrations, a regulated water quality constituent, would exceed water quality standards for both coldwater aquatic life and water supply uses. Short-term, major, adverse impacts during construction and major, long-term, adverse water quality impacts after construction may result from exceedance of the Outstanding Waters standard. Restoration actions would result in long-term, moderate, beneficial water quality improvements by removing some of the suspended sediment and sediment sources. The Lulu City wetland may provide reduced long term, moderate, beneficial sediment and nutrient filtering and retention water quality functions because of surface water hydrologic changes that direct more surface water flow to the central river channel and less sheetflow to other parts of the wetland.

Lulu Creek and Colorado River channel restoration would result in long-term moderate beneficial effects on surface hydrology and stream channel morphology. Major short-term adverse impacts on hydrology and stream channel morphology would occur in Lulu Creek, the Colorado River, and the Lulu City wetland during the sediment removal periods.

The same long-term, moderate, beneficial floodplain floodwater retention and discharge functions described for alternative C would occur for alternative D in zone 3.

IMPACTS OF ALTERNATIVE E – MAXIMUM RESTORATION

Analysis

Alternative E would involve the most mechanical equipment working extensive areas of debris deposits to create stable slopes and protected streambank conditions along the creek, river channels, and the Lulu City wetland in zones 2, 3, and 4, respectively.

The following restoration actions would have water quality effects. The amount of streamside sediment deposits to be protected from slumping and erosion would be substantially increased compared to alternatives C and D. Protection would involve relocating almost all of the alluvial debris fan at the confluence of Lulu Creek and the Colorado River to an adjacent upland location (same as alternative D). Channel step-pools would be either created or enhanced in Lulu Creek (22 structures) and in the Colorado River upstream of the Lulu City wetland (10 structures). Alternative E would also involve several modifications to the Colorado River, including excavating the channel upstream of the Lulu City wetland and blocking the current river channel (same as alternative D); restoring the river channel through the center of the Lulu City wetland by enlarging it (same as alternative C); and blocking off and filling the existing west side river channel (same as alternative C). Alternative E would also excavate surface sediment covering a historical fen on the west side of the meadow. These actions would generate turbidity and suspended sediments where activity was required in the stream channel. The best management practices described in chapter 2 and others identified during later design phases would be applied to alternative E.

A larger quantity of about 69,600 cubic yards of accumulated debris from the 2003 breach and earlier would be removed from the Lulu City wetland. Stream channels within the Lulu City wetland would be altered to direct the primary surface water flows to the historical Colorado River channel near the center of the wetland. The same river wetland floodplain area in zone 3 would be hydrologically reconnected to the river during high snowmelt periods.

Key hydrologic differences with alternative E include excavating and routing Colorado River flow upstream of the river's confluence with the Lulu City wetland; including step-pools in zones 2 and 3; and excavating longer reaches of the historical Colorado River channel in the Lulu City wetland.

Restoration activities would require two to three years because of the greater amount of debris to be removed.

In zones 2 and 3, approximately 8,000 linear feet of channelbank would be stabilized and protected from water erosion along Lulu Creek and the Colorado River below the confluence where debris from the alluvial fan was deposited during the spring 2011 runoff. These creek and riverbank locations have moderate to severe debris erosion potential (figure 4.2).

The confluence alluvial fan would be protected from overbank flooding in Lulu Creek with rocks and boulders using the same approach as that for alternative D. The base of the disposal site would be protected from erosion by high floodflows.

Water Quality. Alternative E would not affect water quality conditions in zone 1 because this zone does not contain surface water or serve as the source of surface water for down-gradient locations.

Alternative E water quality impacts would be similar to those of alternative C. Although the locations of water quality impacts would be different between the two alternatives in some areas, the factors generating the effects and the processes responsible for adverse restoration impacts would be the same. The size of the area affected by alternative E would be larger than alternative C, but these actions would still generate changes that would be considered major, short-term and long-term adverse effects during restoration phases. Changes would be sufficient to exceed water quality standards for nitrates for both coldwater aquatic life and water supply uses and for suspended sediments. These and other water constituents would exceed existing water quality conditions, thus exceeding the Outstanding Waters designation in Lulu Creek, the Colorado River, and the Lulu City wetland.

For the same reasons as described for alternative C, long-term water quality conditions for alternative E would experience a major beneficial improvement as restoration actions take effect. Sediment deposits currently in the Colorado River channel upstream of the Lulu City wetland would continue to move downstream, creating a sediment source for continued wetland sedimentation.

Hydrology and Stream Channel Morphology. Alternative E hydrology and stream channel morphology impacts would be similar in type, but more extensive in quantity than alternatives C and D. Alternative E would modify a total of about 8,000 linear feet of banks and channels to protect banks from erosion and to reduce stream scouring energy. Although the locations of channel modifications and debris excavations would be different between alternatives C and D in some areas, the factors generating the effects and the processes responsible for adverse restoration impacts would be the same. About 5,400 linear feet of channel modifications would occur with alternative E.

Energy dissipating step-pools in Lulu Creek (22 structures) and the Colorado River (10 structures) would be installed or enhanced. These step-pools would reduce channel grade, water velocity, and channel scour potential. In addition to reducing the quantity of sediment transported downstream from the confluence of the Lulu Creek and Colorado River, these step-pools would help stabilize overall stream channel conditions. Step-pools would be expected to gradually migrate and reform during the highest runoff years in response to natural channel-forming processes.

Sediment excavation in the northern and central sections of the Lulu City wetland would affect about 11.1 acres of wetland and would remove an average thickness of 4 feet of sediment deposited by multiple runoff events. Surface water would be routed to the historical Colorado River channel in the wetland using the same techniques that were described for alternative C. Alternative E would excavate the same, entire length of Colorado River channel through the wetland as alternative C. The uncertainty of achieving the desired groundwater flow direction and final water table elevations discussed for the alternative C hydrology analysis would be relatively greater for alternative E because the average depth of sediment excavation (4 feet versus 2 feet with alternative C) would be greater.

Presuming the assessment assumptions previously listed are correct, the pre-breach wetland surface and groundwater hydrologic conditions would be restored. Final wetland ground elevations would be adequate to accommodate the development and maintenance of the post-excavation willow community defined by the reference condition. During restoration the fundamental hydrology of the northern 30% to 50% of the wetland would be changed from current conditions to remove the 2003 sediment and to reshape the wetland surface to accommodate the future hydrology pattern. This hydrology pattern would involve a groundwater table 1 to 2 feet below the ground surface in the willow communities during the late summer months, with most surface water in the wetland moving through a central river channel. These changes would create major, short-term, adverse impacts on hydrology and stream channel morphology for about two to three years during restoration. Following restoration, these changes would have major, long-term benefits in returning surface and groundwater hydrologic, hydraulic, and stream channel characteristics to presumably more natural ecological reference conditions that existed in 1937 (as illustrated in previous figures).

A temporary staging/haul road extending from the Lulu City wetland work area north to the upland sediment disposal area (area I) would involve crossing an existing floodplain wetland area (area M) and the Colorado River twice. These crossings would adversely affect existing hydrology and surface water quality during restoration. Removing this temporary staging/haul road would generate additional water quality impacts two to three years later to return land surface, hydrology, and vegetation to predisturbance conditions in the corridor. Implementing the best management practices listed in chapter 2 (and others defined during later design phases) would keep water quality, hydrology, and channel morphology impacts to a minimum. Nonetheless, these actions would create major, short-term adverse water quality impacts during the restoration period because of the Outstanding Waters designation of the Colorado River and its associated wetlands and because nitrate levels would probably exceed the water supply standard.

Extensive streamside sediment removal from the river floodplain in zone 3 would also restore former spring floodflow retention by wetlands that are currently partially prevented from providing this floodplain function. Because of the greater amount of sediment removal associated with this alternative, flooding would be expected during spring runoff conditions of most years. This would be a moderate, long-term, beneficial impact on floodplain floodflow storage and discharge functions because although the new flooding regime would probably be outside the range of variability of the existing hydrologic regime, it would not be considered an exceptional condition compared to present and former conditions. Alternative E would provide relatively greater benefits than alternatives C and D because the frequency of flooding would be greater.

Cumulative Impacts

Debris deposits have accumulated in the north end of the Lulu City wetland and have caused concurrent alterations of the Colorado River channel location and flow capacity for at least the last 58 years. Alternative E would remove a quantity of debris that is more than the estimated 2003 breach contribution. Restoring the site to pre-2003 hydrology and Colorado River channel morphologic conditions would have a long-term, major, beneficial cumulative impact by creating a wetland ground surface elevation and surface water and groundwater hydrology that probably existed before the 2003 breach. Complete streamside sediment removal from the river floodplain in zone 3 would also restore former spring floodflow retention by wetlands that are currently partially prevented from providing this beneficial floodplain function. This would be a long-term, moderate, beneficial impact.

Conclusion

Short-term and long-term, adverse water quality changes resulting from alternative E restoration measures would be major because nitrate-nitrogen concentrations, a regulated water quality constituent, would exceed water quality standards for both coldwater aquatic life and for water supply uses. Short-term, major, adverse impacts during construction and major, long-term, adverse water quality impacts for several years after construction may result from exceedance of the Outstanding Waters standard. After restoration actions were completed, moderate, long-term, beneficial water quality improvements would result from removing much of the suspended sediment and debris sources. The Lulu City wetland may provide reduced long term, beneficial sediment and nutrient filtering and retention water quality functions because of surface water hydrologic changes that direct more surface water flow to the central river channel and less sheetflow to other parts of the wetland.

Lulu Creek and Colorado River channel restoration would result in long-term, moderate, beneficial effects on surface hydrology and stream channel morphology. Major short-term adverse impacts on hydrology and stream channel morphology would occur in Lulu Creek, the Colorado River, and the Lulu City wetland during restoration periods.

Extensive streamside sediment removal from the river floodplain in zone 3 would also restore former spring floodflow retention and discharge by wetlands that are currently partially prevented from providing this beneficial floodplain function. This would be a long-term, moderate, beneficial impact.

WETLANDS

REGULATIONS, GUIDANCE, AND POLICIES

In addition to the overarching laws and regulations directing preparation of this Environmental Impact Statement identified in chapter 1, the following provide additional guidance and the rationale for the environmental assessment process.

Clean Water Act

The Federal Pollution Control and Prevention Act of 1972, commonly known as the Clean Water Act, is the primary federal law in the United States governing water pollution. The purpose of the act is to make our nation's waters "fishable and swimmable" by 1983 by eliminating releases of toxic substances, controlling wastewater and stormwater pollution of waterways, and instituting water quality standards and associated permitting systems. Section 404 addresses the adverse effects of discharging dredged or fill material to the waters of the United States, including wetlands. For regulatory purposes under the Clean Water Act, the term wetlands means "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." Section 401 of the Clean Water Act gives states and eligible Indian tribes the authority to review and approve, condition, or deny permits or licenses for any Federal activity that may violate a state's water quality standards, including Federal section 404 permitting for dredge and fill activities in wetlands. Section 401 also provides guidance on water quality standards for wetlands.

Executive Order 11990, Protection of Wetlands

Executive Order 11990, Protection of Wetlands, requires federal agencies to avoid the short- and long-term, adverse impacts associated with the destruction or modifications of wetlands whenever possible and to preserve and enhance the natural and beneficial values of wetlands. NPS *Management Policies* (2006) and Director's Order 77-1: Wetland Protection require the National Park Service to protect wetland habitat from degradation and to restore natural wetland functions and values where human activities have disturbed them.

Director's Order #77-1, Wetland Protection

Director's Order #77-1, Wetland Protection (revised April 2011), states "to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative . . . ." and calls for actions with the potential to adversely affect wetlands to prepare a wetland statement of findings along with the appropriate National Environmental Policy Act document. However, Section 4.2.1.h of the director's order allows an exception for "Actions designed to restore degraded (or completely lost) wetland, stream, riparian, or other aquatic habitats or ecological processes" and for actions causing a cumulative total of up to 0.25 acres of new, long-term adverse impacts on natural wetlands if they are directly associated with and necessary for the restoration (e.g., small structures). For this exception, "restoration" refers to reestablishing environments in which natural ecological processes can, to the extent practicable, function as they did prior to disturbance. The proposed action meets this definition of restoration and an exception to the adverse temporary impacts associated with restoration is warranted. Restoration actions would be designed, sized, and constructed to result in less than 0.25 acres of new long-term, adverse wetland impact. Additionally, there are conditions stated in appendix 2 of the Director's Order #77-

1 that are met under the proposed NPS preferred alternative, thus a statement of wetland findings need not accompany this document.

Director's Order #77-1 also establishes a goal of achieving no net loss of wetland acres or functions from wetland compensation actions. In the absence of definitive information needed to specifically address 1:1 wetland function replacement, a minimum of 1:1 wetland acreage replacement may be used as a surrogate (NPS 2011k). The restoration plan intends to fully compensate for the wetland acres and functions that would be affected by construction activities to achieve the goal of no net loss.

METHODS AND ASSUMPTIONS FOR ANALYZING IMPACTS

Geographic Area Evaluated for Impacts

The geographic area to be evaluated for impacts on wetlands from the various alternatives for restoration includes the area defined as wetland under the Cowardin wetland and deepwater habitats classification system (Cowardin et al. 1979), including the limits of jurisdictional wetlands, plus those areas where restoration activities have the potential to affect groundwater supporting jurisdictional wetlands. Wetland areas to be restored for compensation are the same areas that were impacted by the breach, including Lulu Creek, the Colorado River and its floodplain from the Lulu Creek confluence with the Colorado River downstream to the south boundary of the Lulu City wetland, and portions of the Lulu City wetland. The extent, specific locations, and nature of the restoration would vary by alternative.

The terms used to define the extent of a particular effect or impact include the following:

Local effects of an action would affect water resources within relatively small areas within the park, such as a particular stream channel, drainage, or portion of a wetland.

Parkwide effects would affect resources within Rocky Mountain National Park.

Regional effects could occur over the entire park and extend to areas outside the park.

Issues

Internal and public scoping processes identified the following major concerns related to water resources:

- The Grand Ditch breach and the subsequent debris flow have altered the stream channel, floodplain, and wetlands along Lulu Creek and the Colorado River, including the Lulu City wetland, from their natural conditions.
- Sediment deposition and alterations in hydrological conditions have affected the wetland community species composition and distribution, as well as wetland functions, especially in the Lulu City wetland.
- The ability of the wetland to regain its natural condition and functional capability would likely take well over 100 years (Cooper 2007c).

Assumptions

- Wetlands within the project area will be delineated and jurisdictional determinations will be made by the U.S. Army Corps of Engineers.

- The necessary U.S. Army Corps of Engineers Clean Water Act Section 404 permits to discharge “fill” material into wetlands and waters of the US will be obtained. The need for individual or nationwide permit(s) is to be determined.
- Director’s Order #77-1, Appendix 2: Best Management Practices and Conditions for Proposed Actions with the Potential to Have Adverse Impacts on Wetlands will be implemented to minimize potential adverse effects on wetlands. Additional best management practices may be appropriate depending on local conditions or special circumstances. These also serve as "conditions" that must be met for the actions listed in Section 4.2.1 of these procedures to qualify as "excepted." Chapter 2 presents the appendix 2 best management practices. Although not all the best management practices identified would be applicable to each, or in some cases, any of the alternatives, all the practices are presented to provide an understanding of how adverse impacts can be avoided, offset, and/or minimized.

Assessment Methods

The technique used to assess impacts on wetlands from management activities considered under this restoration project is in accordance with *Management Policies* (NPS 2006 Management policies) and *Director’s Order #12: Conservation Planning, Environmental Impact Analysis, and Decision-making* (NPS 2001 – DO 12). The estimated effects of the action alternatives were compared to the effects resulting from a continuation of current management practices. The continuation of current management practices is synonymous with the no action alternative. The assessment of effects considers the effects of specific restoration actions on wetlands, with particular attention to wetland functions, and also includes the effects of best management practices and mitigation measures associated with an alternative. Wetland vegetation is evaluated in the like-named sections of the vegetation chapter. See chapter 2 for a list of the best management practices and mitigation measures that would be implemented to offset and minimize adverse effects on wetlands.

The other plans and projects whose effects could cumulatively combine with the effects of the Grand Ditch breach restoration alternatives were presented in chapter 1. Only plans and projects that would have effects on wetlands within the general geographic area affected by the breach are considered in the assessment of cumulative effects on wetlands. The cumulative effects analyses for each of the alternatives evaluates the effects of the other plans and projects on a particular resource, adds the effects identified by the specific restoration alternative, and then identifies the total cumulative effect, including the degree that the restoration alternative contributes to the overall cumulative effect.

Impact Threshold Definitions

Negligible: Wetland functional values (for example, flood storage and nutrient transfer) and species composition would not be affected, or the effects would be below or at the level of detection. Mitigation measures would not be required.

Minor: Changes to wetland functional values and species composition would be measurable, although the change would affect the degree of a particular functional value provided rather than the absence or addition of a wetland function. Mitigation may be needed to offset adverse effects. If needed, mitigation would likely succeed.

Moderate: Changes to wetland functional values and species composition would be measurable, including a change in the types of functions provided by the wetland community. Mitigation may be needed to offset adverse effects. If needed, mitigation may succeed.

Major: The changes would be severe or exceptional and changes to wetland functional values and species composition would be measurable across the entire wetland community. Mitigation may be needed to offset adverse effects. If needed, mitigation success would not be guaranteed.

Beneficial effects would result in improved or additional wetland functional values consistent with reference conditions.

Adverse effects would result in a loss or degradation of wetland functional values further away from reference conditions.

Short-term: Effects would cease within three years following implementation of the action.

Long-term: Effects would extend more than three years beyond implementation of a restoration action.

IMPACTS OF ALTERNATIVE A – NO ACTION / CONTINUE CURRENT MANAGEMENT

Analysis

Wetland Functions. Primary wetland functions, including, but not limited to, terrestrial and aquatic wildlife habitat, floodflow attenuation and control, sediment retention, groundwater recharge and discharge, maintenance of water quality, and primary biomass production, were affected by the Grand Ditch breach. Sediment deposits buried a minimum of 9.5 acres of wetland and stream ecosystems in the Lulu City wetland complex (Cooper 2006) and about 15.7 acres for all wetlands, stream channels, and riparian areas between Lulu Creek and the south end of the Lulu City wetland. Since a sediment deposition field assessment was completed in 2003 and 2004 (as reported in 2006), spring runoffs have imported additional sediment from upstream deposits further into the interior of the Lulu City wetland. Field observations revealed that spring flows also reworked and transported existing sediment in the wetland further downgradient, thereby expanding the size of the wetland impact. Sediment deposits altered groundwater recharge/discharge capabilities, resulting in the elimination of wildlife habitat, compromised floodflow attenuation, degraded water quality, and reduced primary production.

Some wetland functions have been naturally restored to varying degrees of their former efficacy, and in the case of sediment retention, actually provided this function to a maximal extent as evidenced by the deep sediment layers found in the upstream portions of the Lulu City wetland (zone 4). Sediment retention functions under no action would be long-term, local, and a major beneficial effect as the wetland retained substantial quantities of sediment, preventing movement further downstream.

However, for the majority of the wetland functions, the no action alternative results in reduced capability for wetlands to fulfill their role (Cooper 2006). For example, areas once covered by wetland plants are currently bare; hydrology has changed such that there are large areas of surface sheetflow in the northern portions of the Lulu City wetland that pass over different areas than before; beaver ponds and pools that once retained water providing support for emergent wetlands are filled with sediment and no longer retain water; sections of wetland have been disconnected from the river channel by sediment deposits (including polygon M in zone 3); and, the lowered density of wetland vegetation no longer provides the former resistance to floodflow, thus minimizing the floodflow attenuation function. These reduced wetland characteristics and functions are examples of the long-term, local, major adverse impacts that occur to wetlands under alternative A.

Wetland Acreage and Location. The types of wetlands would be changed under alternative A as a result of the continued presence of sediment deposits that disconnect (zone 3), bury some wetland locations, and encourage the conversion of some wetland locations from emergent willow-sedge complexes to riverine or unconsolidated stream bottom wetlands (zone 4). Additionally, some of what was formerly wetland might be converted to upland as a result of the sediment deposits and changes in depth to the groundwater table (Cooper 2006). This change in wetland types and potential conversion to upland types would represent a long-term, local, moderate to major, adverse effect.

Dominant Wetland Species. The dominant current wetland species in the Lulu City wetlands are willows, sedges, and bluejoint that in some cases have grown in or through the sediment deposits. Hydrological and physical substrate changes, such as burial of native soils, have made growing conditions less suitable for tall willows and other wetland species that, before sediment deposits, contributed to wetland diversity. The loss of wetland species diversity that would continue under alternative A represents a long-term, local, moderate to major, adverse impact on wetlands.

Wetland Soils. The sediment berms deposited along the east bank of the Colorado River in zone 3 have reduced the frequency of Colorado River overbank flows to flood the adjacent wetland. The reduced frequency of normal flood deposits in the wetland represents a local, moderate adverse impact on wetland soil.

Sediments deposited by the 2003 breach range from 0 to almost 40 inches deep in the Lulu City wetland (Cooper 2006). The burial of wetland soil (primarily Kawuneeche mucky peat) placed the nutrient and organic components of the soil at depths that impeded natural regeneration and growth in some locations with the thicker sediment deposits. The water-holding capacity of the sediment would be changed by the deposition and reworking of the parent soils by high streamflows with new influxes of sediments. These adverse impacts would be long term, local, and major.

Potential for Recovery of Wetland Community. Full recovery of the wetland community under the no action alternative, with a full complement of species and restoration of wetland functions would likely take well over 100 years (Cooper 2007c). Zedler (2000) states "In nature, a disturbed habitat immediately begins to change and it continues to develop over centuries." Natural recovery of the Lulu City wetland community would probably be on the scale of tens of decades or even centuries. Continued elk and moose browsing of unprotected willow and sedge plants would substantially extend the wetland and willow recovery processes because most annual plant growth would continue to be consumed by these wildlife species. The long-term degradation of wetland functions would represent a long-term, local, major adverse impact.

Cumulative Impacts

Past, present and reasonably foreseeable actions that affect wetlands in the project area include the park's vegetation restoration management plan (NPS 2006b), backcountry wilderness management plan (NPS 2001a), elk and vegetation management plan (NPS 2007c), bark beetle management plan (NPS 2005a), fire management plan (NPS 2004a), and invasive exotic plant management plan (NPS 2003b). Essentially, whenever wetlands would be affected by actions associated by these plans, wetlands would be protected from adverse impacts. Because none of the plans involve development that would result in direct or indirect wetland take (or adverse effects), the potential contribution of these plans to effects on wetlands would be low, and these plans would all contribute negligible beneficial effects, if any, to wetlands in the long term.

Ongoing operations of the Grand Ditch diverts water resources to the east slope of the Rocky Mountains that would otherwise support wetlands in zones 3 and 4. The water diversion may represent a long-term, local adverse cumulative effect on wetlands because of the reduced water supply. Additionally, previous unnatural debris flows events from operation of the Grand Ditch have contributed sediment into wetlands in zones 3 and 4. These materials represent a long-term, local adverse cumulative effect on wetlands because of the burial of wetland soils and resulting altered groundwater recharge/discharge capabilities.

Collectively, the cumulative effects of past, present, and reasonably foreseeable actions on wetlands would be long term, moderate, and adverse because of the greater proportional adverse contribution of the Grand Ditch water diversion operations and the relatively minor beneficial contribution of the other plans.

Alternative A would result in long-term, local, moderate to major, adverse effects on wetlands.

The cumulative impacts of alternative A combined with the impacts of past, present, and reasonably foreseeable actions would continue to be long term, moderate, and adverse. Alternative A's contribution to the overall cumulative effect would be large.

Conclusion

Overall, alternative A would result in long-term, local moderate to major adverse effects on wetlands because continued buried wetland vegetation would no longer attenuate floodflows as effectively as before the breach, reduce overall vegetated wetland area, reduce wetland diversity with a lower potential to provide habitat for terrestrial and aquatic species, and alter groundwater table characteristics because of sediment deposits. The minor benefits associated with the regeneration of willow and sedge wetlands under no action are limited in their ability to provide wetland functions and are outweighed by the adverse impacts described above.

The cumulative impacts of alternative A combined with the impacts of past, present, and reasonably foreseeable actions would continue to be long term, moderate, and adverse. Alternative A's contribution to the overall cumulative effect would be large.

IMPACTS OF ALTERNATIVE B – MINIMAL RESTORATION

Analysis

Wetland Functions. The restoration actions associated with alternative B would locally benefit wetlands and wetland functions as streambanks are protected in limited areas in zones 2 and 3, and willows and other riparian species are planted in select locations in zone 3. These benefits would accrue as erosion is lessened and bank stability increased that would, in the long-term, reduce the potential for additional sediment deposition in downstream wetlands.

Additionally, the use of wetland turf and/or sedge plantings to revegetate select bare areas in zone 4 would add to the vegetative cover of the wetland, stabilize sediment, and increase the Lulu City wetland's ability to provide wetland functions, such as biomass production and sediment retention.

Although reference conditions would not be fully restored under this alternative, there would be an increase in wetland functions as a result of the stabilization of sediment and the increase in wetland plant biomass. There is value gained even if predisturbance conditions would not be achieved but wetland functions would be improved (Ramsar Convention 2002). Alternative B would result in local, long-term, minor benefits to some wetland functions because of their incremental improvements.

Wetland Acreage and Location. The size of vegetated wetlands would increase under alternative B with planting of willows and sedges in unvegetated sections of zone 4. The total increase in revegetated wetland areas would be minimal, not more than 0.5 acre, and would represent a local, long-term, minor benefit to wetlands because even the smallest increase would improve the ability to provide wetland functions. Restoration activities would have a short-term, moderate, adverse impact on about 0.8 acre of wetland, stream channel, and associated riparian areas.

Dominant Wetland Species. The dominant current wetland species in the Lulu City wetland are willows (mostly planeleaf willow) and sedges that in some cases have grown in or through the sediment deposits. Alternative B would augment the willow and sedge community with willow and sedge plantings or the use of wetland turf. However, this would do little to increase wetland plant diversity. As a result, alternative B would have minimal effect on wetland species diversity.

Wetland Soils. Alternative B would take no actions to remove sediment. Native soils would remain buried under the existing sediment deposits in wetlands. Thus, there would be no difference from the local, moderate adverse impact on wetland soil that was described for alternative A.

Potential for Recovery of Wetland Community. Full recovery of the wetland community under alternative B, with a full complement of species and restoration of wetland functions would likely take over 100 years (Cooper 2007c). Zedler (2000) states "In nature, a disturbed habitat immediately begins to change and it continues to develop over centuries." Natural recovery of the Lulu City wetland community would probably be on the scale of tens of decades or even centuries. Continued elk and moose browsing of unprotected willow and sedge plants would substantially extend the wetland and willow recovery processes because most annual plant growth would continue to be consumed by these wildlife species. Compared to alternative A, there would be an incremental increase in the long-term potential for wetland recovery as a result of sediment stabilization and increased biomass production, but the adverse impact on wetlands would continue to be long-term, local, and moderate to major.

Cumulative Impacts

Past, current, and foreseeable future actions that impact wetlands would be the same as those described for alternative A and would be long term, moderate, and adverse because of the greater proportional adverse contribution of the Grand Ditch water diversion operations and the relatively small beneficial contribution of the other plans.

Overall, alternative B would result in long-term, local, minor, beneficial effects on wetlands by stabilizing sediment and increasing wetland plant biomass.

The local effects of alternative B on wetlands would contribute a small, beneficial cumulative improvement to the effects of past, present, and reasonable foreseeable actions, which would continue to be long term, moderate, and adverse. Alternative B would provide a small beneficial contribution to the cumulative impacts.

Conclusion

Overall, alternative B would result in long-term, local, minor, beneficial effects on wetlands by stabilizing sediment and increasing wetland plant biomass. Restoration activities would have a short-term, moderate, adverse impact on about 0.8 acre of wetland, stream channel, and associated riparian areas.

The local, minor, beneficial effects of alternative B on wetlands would contribute cumulatively to the effects of past, present, and reasonable foreseeable actions, which would continue to be long term, moderate, and adverse. Alternative B would provide a small beneficial contribution to the cumulative impacts.

IMPACTS OF ALTERNATIVE C – HIGH RESTORATION

Analysis

Wetland Functions. The restoration actions associated with alternative C would locally benefit wetlands and wetland functions as streambanks are stabilized in zones 2 and 3, and willows and other riparian species are planted in select locations in zone 3 over a larger area than in alternative B. These benefits would accrue as erosion was lessened and bank stability increased that would, in the long term, reduce the potential for additional sediment deposition in downstream wetlands. Portions of the Lulu Creek alluvial fan would remain, however, and sediment could be released to wetlands under future high flow conditions.

The removal of sediment berms along the Colorado River associated with alternative C would be a moderate benefit for wetlands and wetland functions as a result of reconnecting the surface water supply in zone 3. The restoration of the hydrological connection would be a moderate benefit because the wetland would experience increased water that would enhance and restore several wetland characteristics, including floodflow attenuation, groundwater recharge, and improved water quality, along with an increase in nutrient availability.

The removal of sediment and opening the historical Colorado River channel in zone 4 would require the removal of existing wetland sedges and willows. Although there would be efforts to save some of the plant material and seedbank for reuse wherever possible, there would be a short-term, local, moderate adverse effect of sediment removal as wetland functions would be temporarily discontinued.

In the long term, the removal of sediment and rerouting of the Colorado River to its historical channel would result in major benefits as historical hydrological conditions would presumably be improved. These conditions would in turn provide support for a tall willow wetland community. Many wetland functions would experience major benefits from the establishment of a tall willow community in the Lulu City wetland. Cooper (2007c) estimates that with full restoration of the entire the Lulu City wetland, ecological functions would increase by 25% and wetland functions would be fully restored within 15 years. Although alternative C does not represent full restoration, it does implement some of the most critical actions, including routing the Colorado River through its historical channel, removing a substantial amount of sediment, and planting tall willows; thus, there would be some degree of wetland function restoration as a result of alternative C.

As a result of the effects of alternative C, wetland functions would experience long-term, local, major benefits. The temporary short-term adverse effects on wetlands resulting from sediment removal actions would be offset in the long term as a tall willow wetland became established.

Wetland Acreage and Location. Alternative C would revegetate bare areas in zone 4 with willows and wetland species. This would increase the vegetated wetland area and result in a local, long-term, minor benefit as the larger wetland area would contribute to enhanced wetland functions and because most of the area is already considered wetland. Restoration activities would have a short-term, major, adverse impact on about 18.8 acres of wetland, stream channel, and associated riparian areas.

Dominant Wetland Species. Following removal of sediment in the Lulu City wetland, tall willow species, and other wetland vegetation would be planted in the uncovered native soils. The restoration of the historical Colorado River channel and restored surface water–groundwater interactions would provide hydrological support for a more diverse community (Cooper 2007c). Temporary browsing exclosure fences would protect the planted willows from the adverse effects of herbivory during their establishment phase and would provide a major benefit in protecting the wetland species from elk and moose browsing damage, leading to increased species diversity in the long term. The structural diversity of a tall willow community would enhance wildlife habitat for songbirds as well as provide the tall willow preferred by beaver (Baker et al. 2005). Although beaver populations in the Kawuneeche Valley are low, recovery of this keystone wetland species would be aided by restoration of the tall willow community. The species diversity in the wetlands would experience a long-term, major benefit as a result of the implementation of alternative C by supporting new plant and wildlife species native to the area.

Wetland Soils. The native wetland soils buried by sediment would be partially uncovered by alternative C. The development of these soils occurred over hundreds and possibly thousands of years and the nutrient and organic material content, and water retention capabilities of these soils is greater than the current surface layer of sediment. The native soils would provide a better medium to support the desired tall willow community in addition to being integral to the return of a hydrological flow from north to south rather than the existing easterly flow (Cooper 2007c).

Wetland soils would experience a long-term, local, minor benefit as a result of the implementation of alternative C.

Potential for Recovery of Wetland Community. Full recovery of a diverse wetland community, with a full complement of species and restoration of a full suite of wetland functions would be supported under alternative C. Although not all sediment would be removed, the most seriously degraded areas would be addressed and the potential for recovery would be much greater than if left to natural forces. Enclosing the planted willow areas with fences to exclude elk and moose browsing of the developing stands would accelerate tall willow stand attainment of ecological reference conditions. Concurrent habitat functions for songbird and beaver populations would be supported at levels substantially greater than those of alternatives A and B.

Cumulative Impacts

Past, current, and foreseeable future actions that impact wetlands would be the same as those described for alternative A and would be long term, moderate, and adverse because of the greater proportional adverse contribution of the Grand Ditch water diversion operations and the relatively small beneficial contribution of the other plans.

Overall, Alternative C would result in long-term, local, large, beneficial effects on wetlands because of the removal of sediment and restoration of hydrologic conditions.

Overall, the cumulative effects of all the other plans and projects on wetlands would be long-term and, on balance, likely neutral, as the adverse effects of the Grand Ditch operations would be offset by the benefits for wetlands represented by alternative C. Alternative C's contribution to the cumulative effects would be substantial by removing sediment from the Lulu City wetland, planting tall willows, and restoring historical hydrologic conditions.

Conclusion

Overall, Alternative C would result in long-term, local, major, beneficial effects on wetlands by removing sediment from the Lulu City wetland, planting tall willows to increase habitat and species diversity, protecting willow with temporary browsing exclosure fences, restoring historical hydrologic conditions as a result of sediment removal and rerouting the Colorado River to its historical channel through the Lulu City wetland, and providing a more diverse wetland community. Restoration activities would have a short-term, major, adverse impact on about 18.8 acres of wetland, stream channel, and associated riparian areas.

The cumulative effects of all the other plans and projects on wetlands would be long term and, on balance, likely neutral, because the adverse effects of the Grand Ditch operations would be offset by the benefits for wetlands represented by alternative C. Alternative C would contribute substantially to a long-term, beneficial, cumulative effect on wetlands.

IMPACTS OF ALTERNATIVE D – THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Analysis

All Wetland Characteristics. The types of effects of alternative D on wetlands, and specifically, wetland functions, the wetland species community, soils, the potential for recovery, and the cumulative impacts would be similar to those described for alternative C. Restoration activities would have a short-term, major, adverse impact on about 8.7 acres of wetland, stream channel, and associated riparian areas. It is anticipated that the indirect effects of the restoration activities would beneficially affect a larger portion of the wetlands as suitable hydrology for the reference ecological conditions are established.

The short-term, local adverse effects associated with the removal of sediment and the existing wetland plants would be outweighed by the overall major beneficial effect on wetlands that would accrue as a result of restoration of hydrological conditions and the establishment and protection of a tall willow community with fences. The nature of and the rationale for the major beneficial assessment would be the same as those described for alternative C, although the beneficial effects of alternative D would be greater because of additional actions to reroute and maintain the Colorado River in its historical channel and because of the larger area that would be fenced to protect tall willow development from elk and moose browsing pressure. For these reasons, there would be a net gain in overall Cowardin system and jurisdictional wetland area and functions once restoration activities were complete. The same wetland types would be restored though acreages between wetland types may change based on the characteristics of the wetland hydrology that are established by restoration activities. The recovery potential for the willow community would be the same as alternative C.

Sediment would be selectively removed from the Lulu Creek alluvial fan. The remaining sediment would be protected from water erosion. This would remove a substantial amount of sediment from the project area and reduce the potential for future downstream transport of sediment, thus reducing the potential for adverse effects on wetlands.

Cumulative Impacts

Past, current, and foreseeable future actions that impact wetlands would be the same as those described for alternative A and would be long term, moderate, and adverse because of the greater proportional adverse contribution of the Grand Ditch water diversion operations and the relatively small beneficial contribution of the other plans.

Overall, Alternative D would result in long-term, local, substantial, beneficial effects on wetlands because of the removal of sediment and restoration of hydrologic conditions.

Overall, the cumulative effects of all the other plans and projects on wetlands would be long-term and, on balance, likely neutral, because the adverse effects of the Grand Ditch operations would be offset by the substantial benefits for wetlands represented by alternative D. Alternative D's contribution to the cumulative effects would be substantial by removing sediment from the Lulu City wetland, planting tall willows, and restoring historical hydrologic conditions.

Conclusion

Overall, Alternative D would result in long-term, local, major, beneficial effects on wetlands by removing sediment from the Lulu City wetland, establishing a tall willow community with other wetland plant species to increase habitat and species diversity, protecting willow with temporary browsing exclosure fences, restoring historical hydrologic conditions as a result of sediment removal and rerouting the Colorado River to its historical channel through the Lulu City wetland, and increasing the potential for the enhancement of wetland functions. Restoration activities would have a short-term, major, adverse impact on about 8.7 acres of wetland, stream channel, and associated riparian areas.

The cumulative effects of all the other plans and projects on wetlands would be long term and, on balance, likely neutral, as the adverse effects of the Grand Ditch operations would be offset by the substantial benefits for wetlands provided by alternative D. Alternative D would contribute substantially to a long-term, beneficial cumulative effect on wetlands. There would be no net loss of wetlands as mandated under DO-77.

IMPACTS OF ALTERNATIVE E – MAXIMUM RESTORATION

Analysis

All Wetland Characteristics. The types of effects of alternative E on wetlands, and specifically, wetland functions, the wetland species community, soils, the potential for recovery, and the cumulative impacts would be similar to those described for alternatives C and D. Restoration activities would have a short-term, major, adverse impact on about 21.4 acres of wetland, stream channel, and associated riparian areas. It is anticipated that the indirect effects of the restoration activities would beneficially affect a larger portion of the wetlands as suitable hydrology for the reference ecological conditions are established.

The short-term, local, adverse effects associated with the removal of sediment and the existing wetland plants would be outweighed by the overall major, beneficial effect on wetlands that would accrue as a result of restoration of hydrological conditions and the establishment and protection of a tall willow community using fences. The nature of and the rationale for the major beneficial assessment would be the same as those described for alternatives C and D, although the beneficial effects of alternative E would be greater because the volume of sediment removed would be about four to five times greater than either alternative C or D, with a proportional increase in the area restored. This area would be fenced to protect tall willow development from elk and moose browsing pressure. The recovery potential for the willow community would be the same as alternatives C and D.

Under alternative E, the greatest amount of sediment would be removed from, or stabilized, in zone 2 and the Lulu Creek alluvial fan, reducing the potential for future sedimentation in wetlands. Additionally, an important local fen wetland in zone 4, currently buried by sediment, would be restored by removing sediment and planting fen species that would be protected with temporary browsing exclosure fences. The additional restoration actions of alternative E would result in even greater long-term, local, major, benefits than alternatives C and D for all wetland characteristics.

Cumulative Impacts

Past, current, and foreseeable future actions that impact wetlands would be the same as those described for alternative A and would be long term, moderate, and adverse because of the greater proportional adverse contribution of the Grand Ditch water diversion operations and the relatively small beneficial contribution of the other plans.

Overall, Alternative E would result in long-term, local, substantial, beneficial effects on wetlands because of the removal of sediment and restoration of hydrologic conditions.

Overall, the cumulative effects of all other plans and projects on wetlands would be long term and, on balance, likely neutral, because the adverse effects of the Grand Ditch operations would be offset by the benefits for wetlands represented by alternative E. Alternative E's contribution to the cumulative effects would be substantial by removing sediment from the Lulu City wetland, planting tall willows, and restoring historical hydrologic conditions.

Conclusion

Overall, Alternative E would result in long-term, local, major, beneficial effects on wetlands by removing sediment from the Lulu City wetland, establishing a tall willow community with other wetland plant species to increase habitat and species diversity, protecting willow with temporary browsing exclosure fences, restoring historical hydrologic conditions as a result of sediment removal and rerouting the Colorado River to its historical channel through the Lulu City wetland, and increasing the potential for the enhancement of wetland functions. Restoration activities would have a short-term, major, adverse impact on about 21.4 acres of wetland, stream channel, and associated riparian areas.

The cumulative effects of all other plans and projects on wetlands would be long term and, on balance, likely neutral, because the adverse effects of the Grand Ditch operations would be offset by the substantial benefits for wetlands represented by alternative E. Alternative E would contribute substantially to a long-term, beneficial, cumulative effect on wetlands.

VEGETATION

REGULATIONS, GUIDANCE, AND POLICIES

National Park Service Management Policies

Management Policies states that the “fundamental purpose” of the national park system begins with a mandate to conserve park resources and values and provide for the public enjoyment of the park’s resources and values to the extent that the resources will be left unimpaired for future generations. Section 1.4.6 identifies native vegetation as a park resource, and Section 4.4.2 provides general principles for the maintenance of natural resources in the park by preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native species (NPS 2006a).

METHODS AND ASSUMPTIONS FOR ANALYZING IMPACTS

Geographic Area Evaluated for Impacts

The geographic area to be evaluated for impacts on vegetation from the various alternatives for restoration include those areas directly affected by the Grand Ditch breach. This includes all vegetation in zones 1 through 4 below the breach’s high water line, areas affected by breach-related erosion, plus those areas where changes in surface- and groundwater flows have altered the vegetation.

Issues

The overriding issue regarding vegetation is that the plant species composition and distribution in upland, riparian, and wetland communities have been altered as a result of sediment deposition and changes in hydrologic conditions in the area. The time required for regeneration of vegetation scoured by the debris flow will vary greatly depending on the intensity of the restoration measures. Issues associated with the restoration of vegetation include the degree of interference with the natural regeneration that has occurred since 2003 and the change, in some cases, from an existing vegetation community to another.

Assumptions

The following assumptions are presented to support the subsequent analyses of potential effects of the alternatives on vegetation.

- Plant material for replanting / restoration will be as genetically similar to the local, native vegetation as possible.
- Seed to produce restoration plant material will be collected from as near the project area as possible.
- In lieu of active restoration efforts, the wetland community in the Lulu City wetland (zone 4) would continue to be dominated by water sedge and the trend toward greater domination would continue.
- The indirect effects of the breach on vegetation include edge effects (for example, trees formerly protected within a stand are subject to winds or erosion when the loss of surrounding vegetation creates a new mosaic edge) such as windthrow, bank collapse, or slope failure.

- Redistribution of sediment and breach debris as a result of high flow events would continue to have adverse effects on both newly established and extant vegetation.

Assessment Methods

The technique used to assess impacts on vegetation from management activities considered under this restoration project is in accordance with *Management Policies* (NPS 2006a) and *Director's Order #12: Conservation Planning, Environmental Impact Analysis, and Decision-making* (NPS 2001c). The estimated effects of the action alternatives were compared to the effects resulting from a continuation of current management practices. The continuation of current management practices is synonymous with the no action alternative. The assessment of effects considers the effects of specific restoration actions on vegetation and also includes the effects of best management practices and mitigation measures associated with an alternative. See chapter 2 for a list of the best management practices and mitigation measures that would be implemented to offset and minimize adverse effects on vegetation.

The other plans and projects whose effects could cumulatively combine with the effects of the Grand Ditch breach restoration alternatives were presented in chapter 1. Only plans and projects that would have effects on vegetation within the general geographic area affected by the breach are considered in the assessment of cumulative effects on vegetation. The cumulative effects analyses for each of the alternatives evaluates the effects of the other plans and projects on a particular resource, adds the effects identified by the specific restoration alternative, and then identifies the total cumulative effect, including the degree that the restoration alternative contributes to the overall cumulative effect.

Impact Threshold Definitions

Negligible: No native vegetation would be affected, or some individual native plants could be affected as a result of the alternative, but there would be no change in native species at the community level. Mitigation measures would not be required.

Minor: Effects on native plants would be measurable, however, the plant community, in terms of overall abundance, distribution, and composition, would not be changed. Mitigation may be needed to offset adverse effects. If needed, mitigation would likely succeed.

Moderate: A change would occur at the community level and the effects would be measurable in terms of abundance, distribution, quantity, or quality. Mitigation may be needed to offset adverse effects. If needed, mitigation may succeed.

Major: The change would be severe or exceptional on native plant communities, would be measurable, and would substantially change vegetation community types. Mitigation may be needed to offset adverse effects. If needed, mitigation success would not be guaranteed.

Beneficial effects would result in a vegetation abundance, distribution, community structure or composition increase or improvement toward reference conditions and the potential for exotic plant species infestation would decrease.

Adverse effects would result in a vegetation abundance, distribution, community structure, or composition decrease or further degradation from reference conditions and the potential for exotic plant species infestation would increase.

Short-term: Effects would cease within three years following implementation of the action.

Long-term: Effects would extend more than three years beyond implementation of a restoration action.

IMPACTS OF ALTERNATIVE A – NO ACTION / CONTINUE CURRENT MANAGEMENT

Analysis

Upland Vegetation. The no action alternative would not change how upland vegetation (primarily Engelmann spruce, subalpine fir, lodgepole pine comprising the forest canopy, and grouse whortleberry in the understory) is naturally responding to the effects of the Grand Ditch breach. Natural regeneration of tree species is occurring in the breach impact zone, but it is intermittent in the debris flow and along the periphery of the impact zone. Although seedlings have sprouted, their establishment is tenuous due to erosion-related impacts when debris is reworked or unstable banks collapse as a result of high runoff from snowmelt or intense precipitation. Regeneration of the upland understory, dominated by grouse whortleberry, will require development of a soil substrate and a shade canopy. However, the loss of soil and trees in the breach impact zone, and subsequent loss of a growth substrate and shade, makes understory and forest canopy regeneration a very long-term prospect.

The continued high potential for erosion of banks along the breach impact zones would likely affect some upland vegetation. This effect of alternative A, including loss of trees and understory species as supporting soil erodes, represents a long-term, local, moderate adverse effect on vegetation.

Under the no action alternative, the functions typically provided by upland vegetation, including wildlife habitat, soil stabilization, erosion and water release control, nutrient cycling, ground shading, air purification, and carbon sequestration, are either missing or severely degraded because of the loss and slow regeneration of upland vegetation in all zones where vegetation was lost as a result of the breach.

As a result, the alternative A impact on forest canopy upland vegetation and its functions in the area that was directly affected by the breach debris flow would be local, long-term, adverse, and moderate to major. Because of the even longer time needed for the development of a soil substrate and a shading canopy cover, the impact of no action to the regeneration of understory upland vegetation would be long-term, adverse, and major.

Riparian Vegetation. The no action alternative would primarily affect riparian vegetation in zone 2 (a relatively small riparian component), zone 3 (riparian is the dominant vegetation), and zone 4 (riparian vegetation is present along the wetland periphery).

The large-scale erosion associated with the debris flow and continued instability of banks supporting riparian vegetation would have a mixed effect on riparian vegetation. Erosion, is some cases, would undermine riparian vegetation, thus, the effect would be long-term, local, and moderately adverse. Melanson and Butler (1990) state "Stochastic flood events and variable fluvial conditions are crucial to the development of establishment sites for riparian plants, and act as a primary control on plant succession. Accumulating sediments often create gravel bars at or near the surface of the water where colonizing vegetation creates bands of mixed vegetation occupying different stages of succession" (Melanson and Butler 1990).

There are select locations in zone 3 where riparian species are showing signs of recovery or persistence that would indicate highly localized, long-term, minor benefits as a result of no action. However, there are also locations in zone 3 where debris deposits and continued changes in channel morphology have eliminated and continue to inhibit the establishment of riparian vegetation.

There would be some long-term, highly localized, minor beneficial effects on riparian vegetation associated with alternative A. However, overall, the local adverse effects would occur as erosion, sediment and debris redistribution, and changes in stream channel morphology continue. This would represent a local, long-term adverse effect that varies in intensity depending on specific locations. Over time, the benefits would likely increase and adverse effects diminish as the fluvial system retains greater degree of stability than is currently present.

Wetland Vegetation. Prior to and after the 2003 Grand Ditch breach, wetland vegetation was extremely limited or nonexistent in zones 1 and 2, and wetland function in those zones was inconsequential. Wetlands in zones 3 and 4 were substantially affected by the debris flow as sediment buried willows, sedges, and other wetland species. The no action alternative would not implement actions to actively encourage regeneration of wetland vegetation. While sedges and other herbaceous wetland vegetation have naturally reestablished, natural willow regeneration has been sparse. Groundwater levels have changed as a result of the debris flow.

The wetland vegetation in the project area prior to 2003 was established over periods of hundreds of years or more of ecological succession. The natural regeneration of a similar wetland vegetation community would likely require a similarly long term (Hilderbrand et al. 2005). While wetland vegetation has returned to portions of the sediment deposits in zone 4, the return of a full suite of wetland species similar to the community that existed prior to the breach would be a long-term prospect. The continued instability of upstream sediment and debris makes the likelihood of future transport and deposition likely, as evidenced in 2011. This effect would reverse the beneficial effects represented by regeneration of sedges in the existing sediment deposits as future deposition could result in additional buried wetland vegetation. Overall, the no action alternative would result in long-term, local, moderate adverse effects on wetland vegetation because of the time required for wetland vegetation to naturally restore itself to the degree present prior to the breach.

Exotic Species. Exotic species have been observed in the area impacted by the debris flow (Shorrock 2010) and the potential for further establishment is relatively high because the disturbed soils and substrates are prime grounds for invasive species (Cooper 2006). However, ongoing current management include controls actions, primarily targeting local infestations of Canada thistle (*Cirsium arvense*) and knapweed (*Centaurea* spp.), and these actions would continue under alternative A. As a result, alternative A would have a local, long-term, negligible beneficial effect with regard to exotic species because bare areas would persist but control actions would minimize the establishment of exotic species.

Ecological Requirements. All of the ecological requirements of the vegetation that existed prior to the breach are not currently being met because of the absence or limited depths of soil, changes in hydrological regimes, and the availability of sun/shade. The no action alternative would not implement changes to meet the ecological requirements of the native vegetation and thus, would represent a long-term, local, moderate to major adverse effect on vegetation in the area affected by the breach.

Cumulative Impacts

Past, present, and reasonably foreseeable action with potential to affect vegetation in the project area were previously identified in the purpose and need chapter of this document. These plans and projects include the park's Vegetation Restoration Management Plan (2006), Backcountry Wilderness Management Plan (2001, currently under revision), Elk and Vegetation Management Plan (2007), Bark Beetle Management Plan (2005), and Invasive Exotic Plant Management Plan (2003). Each of these plans inherently conserves and protects park resources. As a result, these plans would all contribute beneficial effects on vegetation in the long term.

Other current or future plans and projects with potential to affect vegetation in the project area, although to a lesser degree than those discussed above, include the Trails Management Plan (1982, ongoing) and Colorado River Cutthroat Trout Management Plan (future). The trails and cutthroat trout management plans, by their nature and by virtue of being implemented within and by the park, have projected long-term beneficial effects on resources, including vegetation. On the other hand, ongoing operations of the Grand Ditch act to divert water resources to the east slope of the Rockies that would otherwise support local vegetation. The water diversion represents a long-term, local, adverse cumulative effect. Vegetation would also continue to be affected by previous unnatural debris flows of the Grand Ditch that resulted in various debris deposits within the northern portion of the Kawuneeche Valley. These deposits have altered soil and groundwater conditions resulting in different vegetation communities than were previously present. Overall, beneficial effects of other park plans combined with the ongoing adverse effects of the Grand Ditch would have a long-term, minor, beneficial effect on vegetation because the net focus would be on resource conservation and protection.

Alternative A would result in long-term, local, minor to major, adverse effects on vegetation

The overall long-term, minor, beneficial effects of these plans and actions would combine with the adverse effects of no action to result in long-term, local minor adverse cumulative effect on vegetation. Although there are multiple plans with beneficial effects on vegetation, alternative A's adverse effects are proportionately greater and immediate, the overall cumulative effect would be adverse. Over time, as natural regeneration and stability returned to the area affected by the breach, the adverse effects of no action would lessen and the long-term cumulative outlook would slowly shift toward beneficial. The contribution of alternative A would be modest.

Conclusion

Overall, alternative A would result in long-term, local minor to major adverse effects on vegetation because of continued upstream erosion, rapidly shifting stream channels, bank instability, and sediment deposition. The benefits associated with regeneration or persistence of vegetation under no action are limited to relatively small areas and are outweighed by the adverse impacts described above.

Alternative A would contribute a modest amount to the overall long-term cumulative adverse effects on vegetation because the effects of no action on vegetation are more pronounced than the combined cumulative benefits of other management plans.

IMPACTS OF ALTERNATIVE B – MINIMAL RESTORATION

Analysis

Upland Vegetation. Successful upland vegetation restoration in zones 2, 3, and 4 would include highly local, long-term, minor benefits as a result of reseeding pockets of grass to assist with bank stabilization. The establishment of grasses would not replace the plant community that existed prior to the breach, but it would stabilize banks and forest edges. Bank stabilization in very localized areas would minimize the loss of trees and be the primary contribution to the beneficial effect on upland vegetation.

Riparian Vegetation. The use of vegetation mats and reseeding of native species along banks and in areas subject to erosion along riparian corridors (mainly in zones 2 and 3) under alternative B would have effects similar to those described for upland vegetation. Namely, erosion would be minimized and riparian species would be given better opportunities for establishment. The effects of alternative B on riparian vegetation would be long-term, local, minor, and beneficial. Restoration efforts in zone 3 would include revegetating areas adjacent to the active river channel with riparian species, resulting in incrementally greater benefits than the actions taken in zone 2.

Wetland Vegetation. The restoration actions associated with alternative B that would affect wetland vegetation would primarily occur in zone 4. The planting of sedges and hydric grasses on bare areas would somewhat enhance soil stability and increase primary plant production. Over the long term, these actions associated with alternative B would result in local, minor benefits to wetland vegetation.

Exotic Species. The effects of alternative B with regard to exotic species would be similar to those described for alternative A, namely local, long term, negligible, and beneficial. There would be an incrementally greater benefit than alternative A because some bare soils would be planted with native species, thus eliminating the availability of a substrate for exotic species establishment.

Ecological Requirements. The limited restoration actions associated with alternative B would result in partial restoration of the conditions needed to meet the full suite of ecological requirements for vegetation. Although the continued presence of sediment deposits overlying native soils, the loss of a forest canopy to provide shading, and the altered groundwater regime would all contribute to less than optimal ecological conditions for vegetation, alternative B's restoration actions would represent a long-term, local, minor benefit to conditions needed for support of native vegetation when compared to the no action alternative.

Cumulative Impacts

Past, current, and foreseeable future actions that impact vegetation would be the same as those described for alternative A. Overall, other plans and projects would have a minor beneficial effect on vegetation because their primary focus would be on resource conservation and protection.

Alternative B would result in long-term, local, minor, beneficial effects on vegetation in a relationship commensurate to the minimal degree of restoration actions.

The beneficial cumulative effects of past, present, and foreseeable future actions would combine with the beneficial effects of alternative B to result in long-term, local, minor, cumulative, beneficial effects on vegetation. Alternative B's contribution to these effects would be modest.

Conclusion

Alternative B would result in long-term, local, minor, beneficial effects on vegetation in a relationship commensurate to the minimal degree of restoration actions that are associated with this alternative.

The minor beneficial effects of past, present, and foreseeable future actions would combine with the minor beneficial effects of alternative B to result in long-term, local, minor, cumulative beneficial effects on vegetation. Alternative B's contribution to these effects would be modest.

IMPACTS OF ALTERNATIVE C – HIGH RESTORATION

Analysis

Upland Vegetation. Alternative C would implement restoration actions that would benefit vegetation in zones 2, 3 and 4 (zone 1 is virtually devoid of vegetation). Specifically, the use of woody material and recontouring slopes to enhance of step-pools in zones 2 and 3, in combination with debris relocation and recontouring in zone 2 and debris removal along the channel in zone 3 would enhance conditions to support upland vegetation along the Lulu Creek and Colorado River channels. Upland vegetation would experience mixed effects as a result of the creation of terraces to store excavated debris. There would be short-term, local moderate adverse effects associated with clearing existing vegetation from the areas where debris is to be stored, while in the long term, local, minor, beneficial effects would occur as a result of replanting upland species on the terraces. Overall, alternative C would provide long-term, local, minor benefits for upland vegetation.

Riparian Vegetation. Using woody material to enhance step-pools in zones 2 and 3 would minimize erosion and support regeneration of riparian trees and shrubs that would contribute to needed woody material loads in the riparian ecosystem in the future (Jansson et al. 2005). Revegetation and recontouring of the banks in areas outside the active channel and above the high water mark in zones 2 and 3 would help to reestablish riparian vegetation communities. The use of temporary browsing exclosure fencing to protect riparian plantings would provide additional benefits as the effects of browsing would be deferred until the plantings could become established. This long-term, local, moderate, beneficial effect associated with alternative C would provide incrementally greater benefits to riparian vegetation in comparison to alternative B.

The creation of a debris storage area, a staging area, and a temporary camp for restoration workers would have short-term, local, minor adverse effects on vegetation as the existing native plants would be removed to accommodate the restoration activities. The areas affected would be revegetated at the end of the project and the adverse effects mitigated.

Wetland Vegetation. Hydrologically reconnecting a portion of zone 3 (area M) with the Colorado River would benefit wetland vegetation by restoring the hydrology that historically supported the wetland vegetation in this area. This would provide a long-term, local, minor benefit to wetland vegetation as bank-overtopping high water events would temporarily flood and saturate the soils in area M (see figure 2.17), and contribute to the other hydrologic inputs (e.g., side-slope drainage) that are currently supporting wetland vegetation.

Other effects on wetland vegetation under alternative C would occur in multiple phases. Initially, the removal of over 16,300 cubic yards of debris and sediment in zone 4 would result in the loss of existing wetland vegetation, mainly sedges and some short willow species. This would represent a short-term, local, minor to moderate adverse effect. However, sediment removal would be followed by revegetation of a tall willow community in the currently buried, native Kawuneeche mucky peat soils. The plantings would be protected from browsing by temporary browsing exclosure fences. As a result, the natural development of wetlands, the reintroduction of wetland vegetation, and a return of greater wetland functions would likely take 15-20 years or longer (Mitsch and Wilson 1996). The revegetation of wetland species in the native hydric soils would represent a long-term, local, major benefit to wetland vegetation and would enable vegetation condition to meet most of the reference conditions for wetland vegetation.

Exotic Species. The effects of alternative C on exotic species would be greater than those described for alternatives A and B, namely local, long term, moderate, and beneficial. There would be an incrementally greater benefit than alternative A because more bare soils would be planted with native species, thus eliminating the availability of a substrate for exotic species establishment.

Ecological Requirements. The restoration actions associated with alternative C would enhance the conditions that support vegetative growth and establishment. The removal of debris and sediment, restoration of step-pools and planting of upland, riparian, and wetland vegetation would benefit the ecological characteristics that vegetation requires. The growth requirements would be better met because soils development would be encouraged as erosion would be limited, sediment would be excavated from over native soils, and upland planting and restoration would eventually develop a forest canopy, providing shade for those species that require it.

Alternative C would provide a long-term, local, major benefit to the ecological parameters needed for successful restoration of vegetation and the more intensive restoration efforts associated with alternative C would represent a greater benefit than alternative B. The stated goal of trying to achieve a reference condition represents a greater benefit because the establishment of an ecologically sound endpoint (the reference condition), including sediment and debris removal, is viewed as one of the necessary criteria for a successful restoration project (Palmer et al. 2005). The erosion-control restoration actions associated with alternative C represent an added benefit because the cessation of continued degradation can be a crucial first step in ecological restoration and is integral to successful restoration in upland (Kauffman et al. 1997) and riparian habitats (Goodwin et al. 1997).

Cumulative Impacts

Past, current, and foreseeable future actions that impact vegetation would be the same as those described for alternative A. Overall, other plans and projects would have a beneficial effect on vegetation because their primary focus would be on resource conservation and protection.

Alternative C would result in long-term, local, major, beneficial effects on vegetation in a direct proportion to the degree of restoration actions that are associated with this alternative.

The beneficial cumulative effects of past, present, and foreseeable future actions would combine with the beneficial effects of alternative C to result in long-term, local, major, cumulative beneficial effects on vegetation. Alternative C's contribution to these effects would be substantial.

Conclusion

Overall, alternative C would result in long-term, local, major, beneficial effects on vegetation in a direct proportion to the degree of restoration actions that are associated with this alternative. The short-term, local adverse effects on upland vegetation lost during development of debris storage terraces would be outweighed by the eventual establishment of upland vegetation on the terraces. This relationship is based on the actions to control erosion, replant upland, riparian, and wetland vegetation, remove sediment and debris, and install temporary browsing exclosure fences to protect new plantings. The benefits associated with alternative C would be incrementally greater than alternative B because of its added restoration actions.

The beneficial cumulative effects of past, present, and foreseeable future actions would combine with the major beneficial effects of alternative C to result in long-term, local, major, cumulative beneficial effects on vegetation. Alternative C's contribution to these effects would be substantial.

IMPACTS OF ALTERNATIVE D – THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Analysis

Upland Vegetation. Revegetation of upland species above the high water mark in zone 2, in addition to erosion control recontouring and bank stabilization throughout zones 2 and 3 would result in long-term, local, minor benefits similar to those described for alternative B (and similar to the debris terrace effects described for alternative C). These beneficial impacts would result because the restoration actions would support the regeneration of upland species as erosion would be managed and the replanting would accelerate the reestablishment of native upland vegetation.

Riparian Vegetation. The beneficial effects of alternative D on riparian vegetation would be similar to those described for alternative C (long term, local, and moderate) because the replantings, erosion-control measures, and restoration of step-pools in zones 2 and 3 would enhance conditions suitable for the establishment and growth of riparian species.

Wetland Vegetation. Alternative D would provide benefits to wetland vegetation similar to, although slightly less than, those described under alternative C. The incrementally smaller benefits would still be substantial and would result from the restoration of the Colorado River to its historical channel (long-term, local, minor benefit) and the establishment of a tall willow community in the Lulu City wetland (long-term, local, major benefit). Similar to alternative C, there would be short-term, local, minor to moderate, adverse effects from restoration activities. Note that the effects on wetland functions are evaluated in the wetland section of the analyses.

Exotic Species. The effects of alternative D with regard to exotic species would be similar to those described for alternative C, namely local, long term, moderate, and beneficial. There would be an incrementally greater benefit than alternatives A and B and the same as alternative C because more bare soils would be planted with native species, thus eliminating the availability of a bare soil substrate for exotic species establishment.

Ecological Requirements. Alternative D would have similar beneficial effects on the ecological requirements for vegetation as those described for alternative C. The removal of sediment, bank stabilization, and replanting would contribute to a long-term, local, major benefit as the ecological requirements for native vegetation would be restored and met by alternative D.

Cumulative Impacts

Past, current, and foreseeable future actions that impact vegetation would be the same as those described for alternative A. Overall, other plans and projects would have a beneficial effect on vegetation because their primary focus would be on resource conservation and protection.

Alternative D would result in long-term, local, major, beneficial effects on vegetation in a direct proportion to the degree of restoration actions that are associated with this alternative.

The beneficial cumulative effects of past, present, and foreseeable future actions would combine with the beneficial effects of alternative D to result in long-term, local, major, cumulative beneficial effects on vegetation. Alternative D's contribution to these effects would be substantial.

Conclusion

Alternative D would result in long-term, local, major, beneficial effects on vegetation directly proportional to the degree of restoration actions that are associated with this alternative. This relationship is based on the actions to control erosion; replant upland, riparian, and wetland vegetation; remove sediment and debris; and install temporary browsing exclosure fences to protect new plantings. The benefits associated with alternative D would be incrementally greater than alternatives B because of its additional restoration actions.

The beneficial cumulative effects of past, present, and foreseeable future actions would combine with the major, beneficial effects of alternative D to result in long-term, local, major, cumulative, beneficial effects on vegetation. Alternative D's contribution to these effects would be substantial.

IMPACTS OF ALTERNATIVE E – MAXIMUM RESTORATION

Analysis

Upland, Riparian, and Wetland Vegetation. The beneficial effects of alternative E on vegetation in zones 2, 3, and 4 would be similar to, but incrementally greater than those described for alternatives C and D. The long-term, local, moderate to major, beneficial effects would accrue at a greater rate because the restoration actions including, bank stabilization, channel enhancement, replanting, sediment removal, temporary browsing exclosure fences which would be implemented over a larger area and more often.

Exotic Species. The effects of alternative E with regard to exotic species would be similar to those described for alternatives C and D, namely local, long term, moderate, and beneficial. There would be an incrementally greater benefit than alternatives A and B, and the same as alternatives C and D because more bare soils would be planted with native species, thus eliminating the availability of a bare soil substrate for exotic species establishment.

Ecological Requirements. Much like the effects of alternatives C and D, alternative E would have long-term, local, and major benefits to the ecological requirement for vegetation because of the increase in restoration actions taken to stabilize the area affected by the debris flow.

Cumulative Impacts

Past, current, and foreseeable future actions that impact vegetation would be the same as those described for alternative A. Overall, other plans and projects would have a beneficial effect on vegetation because their primary focus would be on resource conservation and protection.

Alternative E would result in long-term, local, major, beneficial effects on vegetation in a direct proportion to the degree of restoration actions that are associated with this alternative.

The beneficial cumulative effects of past, present, and foreseeable future actions would combine with the beneficial effects of alternative E to result in long-term, local, major, cumulative, beneficial effects on vegetation. Alternative E's contribution to these effects would be substantial.

Conclusion

Alternative E would result in long-term, local, major, beneficial effects on vegetation in a direct relationship proportional to the degree of restoration actions that are associated with this alternative.

This relationship is based on the actions to control erosion, replant upland, riparian, and wetland vegetation, remove sediment and debris, and install temporary browsing exclosure fences to protect new plantings. The benefits associated with alternative E would be incrementally greater than alternatives C and D because of its additional restoration actions.

The beneficial cumulative effects of past, present, and foreseeable future actions would combine with the major, beneficial effects of alternative E to result in long-term, local, major, cumulative, beneficial effects on vegetation. Alternative E's contribution to these effects would be substantial.

SPECIAL STATUS SPECIES

REGULATIONS, GUIDANCE, AND POLICIES

Under the Organic Act of 1916 and *Management Policies* (NPS 2006a) the National Park Service will survey for, protect, and strive to recover all species native to national park system units that are listed under the Endangered Species Act. The National Park Service will fully meet its obligations under the NPS Organic Act and the Endangered Species Act to both proactively conserve listed species and prevent detrimental effects on these species. To meet these obligations, the National Park Service will:

- Cooperate with the U.S. Fish and Wildlife Service and state agencies to ensure that National Park Service actions comply with both the written requirements and the spirit of the Endangered Species Act. This cooperation should include the full range of activities associated with the Endangered Species Act, including consultation, conferencing, informal discussions, and securing all necessary scientific and/or recovery permits;
- Undertake active management programs to inventory, monitor, restore, and maintain listed species' habitats and control detrimental nonnative species;
- Manage detrimental visitor access and reestablish extirpated populations as necessary to maintain the species and the habitats upon which they depend;
- Manage designated critical habitat and recovery areas to maintain and enhance their value for the recovery of threatened and endangered species;
- Cooperate with other agencies to ensure that the delineation of critical habitat and/or recovery areas on park-managed lands provide needed conservation benefits to the total recovery efforts being conducted by all the participating agencies;
- Participate in the recovery planning process, including the provision of members on recovery teams and recovery implementation teams where appropriate; and
- Cooperate with other agencies, states, and private entities to promote candidate conservation agreements aimed at precluding the need to list species; and conduct actions and allocate funding to address endangered, threatened, proposed, and candidate species.

The Endangered Species Act of 1973 established protection over and conservation of threatened and endangered species and the ecosystems upon which they depend. An "endangered" species is a species that is in danger of extinction throughout all or a significant portion of its range, while a "threatened" species is one that is likely to become endangered within the foreseeable future throughout all or in a significant portion of its range. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service jointly administer the act and are also responsible for the listing of species (designating a species as either threatened or endangered). The U.S. Fish and Wildlife Service has primary management responsibility for terrestrial and freshwater species, while the National Marine Fisheries Service has primary responsibility for marine species. The Endangered Species Act allows the designation of geographic areas as critical habitat for threatened or endangered species.

The Endangered Species Act requires federal agencies to conserve listed species and consult with U.S. Fish and Wildlife or National Marine Fisheries Service to ensure that proposed actions that may affect listed species or critical habitat are consistent with the requirements of the act.

METHODS AND ASSUMPTIONS FOR ANALYZING IMPACTS

Geographic Area Evaluated for Impacts

The geographic focus of this analysis is the area of the Upper Kawuneeche Valley impacted by the Grand Ditch breach. Impacts on special status species are evaluated for each of the zones defined by this environmental impact statement, as shown in figure 1.5, as well as the greater Upper Kawuneeche Valley that supports these species.

Issues

Issues that were identified during internal and public scoping regarding restoration activity effects on listed species include the following:

- The potential for management actions in the project area to produce downstream effects on special status species.
- Direct physical impacts on special status species' habitat including trampling or soil disturbance, for example.

Assumptions

The following general assumptions were used to analyze the effects of restoration actions on special status species populations, distribution, and behavior:

- Work would progress in multiple locations simultaneously.
- Work would be conducted during daylight hours.
- Work would be limited to those months of the year where weather allows for access to project area, generally during the late spring and summer months.
- Mitigation measures, including species surveys, would be conducted prior to the start of restoration activities to ensure the health of those sensitive populations.

Assessment Methods

Impacts on special status species include any activity that may be considered a "taking" or that may cause harm to a species as defined under the Endangered Species Act, including harassment and degradation or loss of habitat. Potential effects on a listed species are treated very conservatively to provide maximum protection. Long-range effects of seemingly beneficial actions must be evaluated for potential impacts on listed species. Potential impacts on special status species or their habitat were evaluated based on the known presence of a species or its potential presence due to suitable available habitat. The methods used to evaluate the impacts on special status species used alternative A, the no action alternative as the baseline condition against which the action alternatives were compared because alternative A represents current management conditions. The analysis focuses on the effects on special status species with respect to the implementation of the restoration actions described in Alternatives B, C, D, and E. To understand the effects of restoration activities in the Grand Ditch breach area on listed species, park resource inventories and management plans, scientific literature, and published technical data were consulted to analyze different resource management approaches in addition to consultation with park resource specialists.

The other plans and projects whose effects could cumulatively combine with the effects of the Grand Ditch breach restoration alternatives were presented in chapter 1. Only plans and projects that would have effects on special status species within the general geographic area affected by the breach are considered in the assessment of cumulative effects on special status species. The cumulative effects analyses for each of the alternatives evaluates the effects of the other plans and projects on a particular resource, adds the effects identified by the specific restoration alternative, and then identifies the total cumulative effect, including the degree that the restoration alternative contributes to the overall cumulative effect.

Listed Species to Be Evaluated

Common Name	Scientific Name	Status
Boreal toad	*Bufo boreas boreas*	SE
Wood frog	*Rana sylvatica*	SSC
Colorado River cutthroat trout	*Oncorhynchus clarki pleuriticus*	SSC
River otter	*Lutra canadensis*	ST
Canada lynx	*Lynx canadensis*	FT, SE
Wolverine	*Gulo gulo luscus*	FT, SE

Key to Status: FE = federally endangered; FT = federally threatened; FC = federal candidate for listing; SE = state endangered; ST = state threatened; SSC = state species of special concern

Impact Threshold Definitions

Negligible: If the action would affect an individual of a listed species or its critical habitat, the change would be so small that it would not be of any measurable consequence to the protected individual, its population, or its critical habitat; a discountable effect. Mitigation measures would not be required.

Minor: The action would result in detectable effects on an individual (or individuals) of a listed species or its critical habitat, but the action would not result in substantial population fluctuations and would not have any measurable effects on a species or their critical habitats. Mitigation may be needed to offset adverse effects. If needed, mitigation would likely succeed.

Moderate: The action would result in detectable effects on individuals or a population of a listed species, or its critical habitat. Mitigation may be needed to offset adverse effects. If needed, mitigation may succeed.

Major: The action would result in severe or exceptional effects on individuals or a population of a listed species, or its critical habitat. An adverse effect may include mortality for special status individuals. A major, adverse effect could, in some cases, “jeopardize the continued existence of the species or the integrity of critical habitat.” Mitigation may be needed to offset adverse effects. If needed, mitigation success would not be guaranteed.

Beneficial effects are likely to protect, restore, or encourage improvements in the abundance and distribution of a listed species or its critical habitat toward reference conditions.

Adverse effects are likely to result in undesirable changes in the abundance or distribution of a listed species or its critical habitat.

Short-term: Effects would cease within three years following implementation of the action.

Long-term: Effects would extend more than three years beyond implementation of a restoration action.

IMPACTS OF ALTERNATIVE A – NO ACTION / CONTINUE CURRENT MANAGEMENT

Alternative A would involve the continuation of current management of the area impacted by the 2003 Grand Ditch breach. Alternative A represents current conditions and is therefore the baseline against which the action alternatives are compared.

The National Park Service would continue current management of the impacted area, following existing management policies and NPS guidance. The park would not undertake any active restoration but would continue to rely on natural processes to restore the hydrologic conditions and biotic integrity of the area.

Analysis

Boreal Toad. While no boreal toads were observed during a 2009 survey, the species has a historical presence in the project area. In 1998, two toads were observed on the bank of the Colorado River near the Lulu City site, in the northern reaches of zone 4, just downstream from the confluence of the Colorado River and Little Dutch Creek. Additionally, in 2005, after the Grand Ditch breach, a female boreal toad was observed at a pond near Lulu City in zone 3, north of the Little Dutch Creek/Colorado River confluence.

The 2009 boreal toad survey identified suitable habitat in the eastern portion of the Lulu City wetland, the only area within the project area identified as such. Under the no-action alternative, the park would continue current management of the project area, which may result in further toad habitat degradation from sediment buildup in the Lulu City wetland complex. Additionally, during high flow events, the project area may be further impacted by erosion, large deposits of debris, and lost vegetation. Combined, these impacts would further degrade the habitat of the boreal toad in the Lulu City wetland, and the greater project area. This habitat degradation would create long-term, minor adverse effects on the boreal toad.

Wood Frog. Wood frogs in Colorado inhabit subalpine marshes, bogs, pothole ponds, beaver ponds, lakes, stream borders, wet meadows, willow thickets, and forests bordering these mesic habitats (Natural Diversity Information Source, no date). Wood frogs are known to occur in the Kawuneeche Valley although Scherer's (2010) wood frog surveys did not detect any wetlands containing wood frogs within the project area. Most of the frog observations were clustered farther south in the valley; however, there were some observations within approximately 2 miles of the Lulu City wetland.

Under the no-action alternative, the park would continue current management of the project area, which may result in impacts on the wood frog similar to those on the boreal toad. Habitat degradation from sediment buildup would be expected throughout the project area. Additionally, during high flow events, the project area may be further impacted by erosion, large deposits of debris, and lost vegetation. Combined, these impacts would further degrade the habitat of the wood frog in the greater project area. This habitat degradation would create long-term, minor adverse effects on the wood frog.

Colorado River Cutthroat Trout. The Colorado River cutthroat trout is native to the Upper Colorado River Basin and is found throughout the basin. The trout is known to occur in the Colorado River in project zones 3 and 4 (Kennedy and Rosenlund 2011) and near the headwaters of the Colorado River, which is approximately 2 miles upstream from Lulu Creek's intersection with the Colorado River (U.S. Forest Service 2009). The Colorado River runs through project zones 3 and

4, and the impact on the river from the Grand Ditch breach is primarily due to heavy sediment deposition and altered hydrologic conditions as a result of the breach.

In the project area, the primary concern for the Colorado River cutthroat trout is the increased sediment deposition resulting from the breach. Abrupt sediment releases may cause pool infilling, fining of the channel-bed substrate, formation of lateral bars or tributary mouth deposits, and aggradation and loss of conveyance. These changes in channel morphology are likely to adversely impact fish populations by covering spawning gravels, reducing pool overwinter and resting habitat, and altering macroinvertebrate habitat and community composition (Rathburn and Wohl 2003). Spawning gravels range in size from 10-30 mm and the composition of the substrate, particularly the proportion of fine particles, has been linked to the survival from deposition to fry emergence (U.S. Forest Service 2009). An altered composition of the river bottom from sediment may impact the spawning success in the area. Additionally, local water velocity and depth is important for redd development, and both factors have been altered in areas of the river as a result of the breach. Lastly, the accumulation of sediment would also lead to increased turbidity in the river, impacting local water quality. These impacts are potentially serious for spawning and the health of the local population; however, given the relatively stable population of the Colorado River cutthroat trout in restoration zones 3 and 4 since the sediment release in 2003, the size of the Colorado River basin, and the reach of the Colorado River in the Kawuneeche Valley, the impacts would be diminished by healthy habitat both upstream and downstream from the project site. Also, the impacts would not likely result in population-level effects. Therefore, the impacts on the Colorado River cutthroat trout under alternative A would be long-term, negligible to minor, and adverse.

River Otter. River otter population surveys conducted in the park over the last decade do not suggest that a sizeable population exists in the Kawuneeche Valley (Ben-David 2010). Otters may occur in the project area and the effects of sediment deposition and turbidity may impact foraging activity in the area. However, because otters are transient and large swaths of riparian habitat exist downstream from the project area, the continued management of the project area would not likely impact the species because the otter has ample habitat throughout the rest of the Kawuneeche Valley available to it.

Canada Lynx. Rocky Mountain National Park contains approximately 145,815 acres (55% of the park) of potential Canada lynx habitat. For denning, lynx use dense, mature coniferous forest habitats with large woody material and deadfalls in close proximity to the early successional forests that provide foraging habitat (Koehler and Aubry 1994). The predominant impacts of the Grand Ditch breach did not largely affect mature and early successional forests which provide primary lynx habitat. The main impacts of the breach include the alteration of the hydrologic regime and subsequent plant communities in the Lulu City wetland; impacts on aquatic, riparian, and upland ecosystems; erosion; large deposits of debris; and lost vegetation. Though the lynx is known to frequent riparian areas during the summer, the impacts on these areas from the breach did not likely alter lynx habitat enough to prevent the species from accessing the area. Additionally, in relation to the size of lynx habitat in the park, the breach area would be considered a relatively small fragment of the total riparian habitat.

The altered ecological conditions resulting from the breach may have slightly impacted lynx occurrences in the breach area; however, these impacts would be so small as to be considered inconsequential. As a result, alternative A would have no effect on the Canada lynx.

Wolverine. Wolverines do not appear to specialize on specific vegetation or geological habitat aspects, but instead select areas that are cold and receive enough winter precipitation to reliably maintain deep persistent snow late into the warm season (USFWS 2010). In Rocky Mountain

National Park, only one wolverine has been spotted, in 2009 in the Never Summer Range located along the park's northwest boundary. Because of the species' requirement for persistent cold and snow, the wolverine is likely restricted to high elevations in the park. While this does not disqualify the breach area from hosting the wolverine, it is unlikely that it supports any denning habitat for the animal. Similar to the lynx, it is unlikely that the main impacts of the Grand Ditch breach impacted important wolverine habitat.

The home ranges of adult wolverines range from less than 62 square miles to over 560 square miles (Banci 1994). Given the relatively small size of the Grand Ditch breach area, and the fact that the area does not likely support denning wolverines, alternative A would have no effect on the wolverine.

Cumulative Impacts

In recent years, low-flying commercial air tours over the park and the use of snowmobiles on Trail Ridge Road have been banned. Wildlife vary in their responses to noises, but loud noise can negatively affect many species through changes in behavior and physiological effects (USAF and USFWS 1988). These bans represent a long-term, minor, regional beneficial effect for special status species.

Many actions in the park and on adjacent lands target on improving forest health by controlling the pine bark beetle and managing forest fuels through mechanical thinning and prescribed fire. These actions are detailed in plans such as the Rocky Mountain National Park Fire Management and the Bark Beetle Management Plan, among others. These activities would adversely affect terrestrial special status species as a result of temporary displacement and short-term alteration of habitat, representing a short-term, minor, adverse effect. However, these management plans would continue to help maintain ecosystem structure, composition, and function and conserve biological diversity in the park (NPS 2011l). Overall, these actions would result in long-term, minor to moderate, beneficial effects on special status species as a result of improved habitat conditions.

A series of construction and trail projects (Trails Management Plan and the Trail System Maintenance and Reconstruction Plan) would temporarily displace wildlife, particularly Canada lynx and wolverine, and permanently remove relatively small portions of habitat. The effects of these projects would be both short term, minor, and adverse and long term, negligible, and adverse.

Management plans for protecting the park's natural resources would benefit special status species by maintaining and restoring natural conditions and limiting intrusive activities. Effects associated with these management plans would be long term, minor to moderate, and beneficial. Restoring vegetative communities and removing exotic plants in the park (Invasive Exotic Plant Management Plan, Vegetation Restoration Management Plan) would also enhance wildlife habitat, a long-term beneficial effect on special status species. The Elk and Vegetation Management Plan is intended to limit the elk population and restore native vegetation, particularly willow and aspen communities. The plan would have long-term, parkwide, moderate, benefits on the riparian and wetland special status species, including the boreal toad, wood frog, Colorado River cutthroat trout, and river otter.

Restoration of a native fish species in the park would reduce non-native species and enhance aquatic habitats, a long-term, moderate benefit for the Colorado River cutthroat trout and river otter. However, the restoration could also potentially involve the use of piscicides, which could remove aquatic life in short reaches of streams, resulting in a short-term, moderate, adverse effects on these species.

Activities outside the park also affect wildlife species within the park, as individuals outside can be part of the same population as those within the park. Development outside the park would continue to fragment and reduce wildlife habitat outside the park, a long-term, regional, moderate to major, adverse effect on the wide-ranging Canada lynx and wolverine. Hunting and fishing outside of the park would continue to be managed so that habitat conditions are not degraded by overpopulation of species that may grow in the absence of predators.

There are species-specific management plans, current and planned, for the boreal toad (*Captive Breeding Program of Boreal Toads / Reintroduction into Rocky Mountain National Park and Conservation Plan* and *Agreement for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad* [Bufo boreas boreas]), the Colorado River cutthroat trout (*Conservation Strategy for Colorado River Cutthroat Trout (Oncorhynchus clarkia pleuriticus) in the States of Colorado, Utah, and Wyoming*), and the Canada lynx and wolverine (*State of Colorado Conservation Strategy for Lynx and Wolverine* and the *Lynx Conservation Agreement and Strategy*). These efforts to restore habitat and improve the health of special status species populations both in and around the park constitute a long-term, local and regional, moderate to major, beneficial impact.

Overall, the past, present, and future projects that may affect special status species in Rocky Mountain National Park are anticipated to have long-term, moderate, beneficial impacts both within and beyond the Grand Ditch breach project area. Though short-term construction and restoration activities associated with outside projects may potentially disrupt these species, the overall scope of these plans are focused on restoring ecological balance and forest health while limiting human disturbance.

Under alternative A, impacts would generally result in long-term, local, minor adverse effects on the boreal toad, wood frog, and Colorado River cutthroat trout; this alternative would have no effect on the river otter, Canada lynx, or wolverine. Combined, the cumulative impacts from alternative A and past, present, and future projects would be long-term, moderate, and beneficial for the boreal toad, wood frog, Colorado River cutthroat trout, river otter, Canada lynx, and wolverine. The contribution of alternative A to adverse cumulative impacts would not be substantial.

Conclusion

Adverse effects would result from the changes to hydrology and riparian habitats in the project area after the 2003 Grand Ditch breach. The continued management of the project area under alternative A would result in long-term, local, minor adverse effects on the boreal toad and wood frog, and negligible to minor effects on the Colorado River cutthroat trout because these species rely on these habitats locally. Under alternative A, there would be no impacts on the river otter, Canada lynx, or wolverine because their habitats and ranges are widespread and the project area represents only a small portion of their range.

Combined with past, present, and future projects, the cumulative impacts would be long term, beneficial, and moderate for the boreal toad, wood frog, Colorado River cutthroat trout, river otter, Canada lynx, and wolverine. The contribution of alternative A to adverse cumulative impacts would not be substantial.

IMPACTS OF ALTERNATIVE B – MINIMAL RESTORATION

Alternative B would emphasize a smaller scale of management activity, compared with the other action alternatives, to restore portions of the impacted area. This alternative would focus actions on areas that are unstable and present a high potential of continued degradation of existing ecosystem resources and services. Restoration activities would be conducted using hand tools and would provide stabilization of limited areas of unstable slopes and banks. Under alternative B, there would be no active management to change the hydrologic conditions, and the National Park Service would instead rely upon natural processes to restore the hydrologic channel stability condition in the stream channels and wetland areas.

Analysis

Boreal Toad. While there are no known individuals within the project area, restoration activities under alternative B could serve as a deterrent to the boreal toad movement into the project area, particularly in zone 4, which supports potential breeding habitat (NPS 2009). Because this alternative utilizes hand tools for restoration work, the impacts on the boreal toad from restoration activities would be highly localized and would represent a short-term, negligible to minor adverse impact.

The restoration work performed under this alternative would help, to a small degree to reduce sediment flow into the Lulu City wetland, thereby improving habitat for the toad in the wetland. Because breeding habitat for the boreal toad includes lakes, marshes, ponds, bogs, and wet meadows (Loeffler 2001), any improvements to these habitats in the breach area would provide enhanced habitat for the toad. Zones 3 and 4, in particular, support potential habitat conditions for the boreal toad. This improvement of habitat in an area known to historically support boreal toads would have a long-term, minor, beneficial effect on the species.

Wood Frog. There are no known individuals within the breach area and the nearest known population of wood frogs is approximately 2 miles south of the Lulu City wetland (Scherer 2010). Nevertheless, restoration activities under alternative B could serve as a deterrent to wood frog settlement in the project area during the work, particularly in zone 4 which supports the wetland/wet meadow and stream border habitat that wood frogs are known to utilize. Because this alternative utilizes hand tools for restoration work, the impacts on the boreal toad from restoration activities would be highly localized and would represent a short-term, negligible adverse impact.

The restoration work performed under this alternative would help, to a small degree to reduce sediment flow into the Lulu City wetland, thereby improving habitat for the frog in the wetland. The wood frog inhabits subalpine marshes, bogs, stream borders, wet meadows, willow thickets, and forests bordering these mesic habitats (Natural Diversity Information Source, no date), and restoration activities along the banks of the Colorado River that stabilize and revegetate the project area would greatly enhance the habitat conditions for the wood frog in those localized areas. This restoration work would improve potential habitat conditions for the wood frog and would have a long-term, localized, minor, beneficial effect on the species.

Colorado River Cutthroat Trout. Under Alternative B, the park would provide stabilization for limited areas of unstable slopes and banks along the Colorado River and its local tributaries. Additionally, small amounts of debris and sediment would be removed and redistributed from select locations along the project area with a focus on reducing erosion. These actions would help to reduce, to a small degree, sediment deposition and turbidity throughout the project area, which would both serve to improve habitat for the Colorado River cutthroat trout by improving water quality and substrate composition. Because the project area only represents a limited portion of the trout's habitat, impacts from alternative B would be primarily felt by the local population of Colorado River cutthroat trout. As a result, the restoration activities under alternative B would have local, long-term, negligible to minor, beneficial impacts on the Colorado River cutthroat trout.

River Otter. This alternative would create minimal disturbance in the breach area, primarily resulting from the presence and activity of work crews. However, because the river otter uses habitat beyond the reach of the project area, forage areas outside of the project would provide alternate forage areas for individuals along the Colorado River. The work under alternative B would have short-term, minor, adverse impacts on the river otter in the project area by disrupting foraging in the restoration area and immediate vicinity. Any effects on the otter would be perceived on an individual level.

Under alternative B, limited areas of unstable slopes and banks along the Lulu Creek and the Colorado River would be stabilized. Additionally, small amounts of debris and sediment would be removed and redistributed from select locations along the project area with a focus on reducing erosion. These actions would help to reduce, to a small degree, sedimentation and turbidity throughout the project area, which would both serve to improve habitat for the river otter by improving water quality. The project area only represents a limited portion of the otter's habitat, but because of the otter's scarcity in the park, the improved habitat would have local, long-term, negligible, beneficial impacts on the species.

Canada Lynx. Ruediger et al. (2000) cite risk factors with potential to adversely affect Canada lynx in terms of productivity, mortality, movement, or other large-scale risk factors. Of these risk factors, actions associated with this alternative in zone 1A would be categorized as disturbances primarily affecting lynx movement. Impacts on the lynx from restoration in zone 1A would be short-term and minor adverse, though mitigation measures would be implemented to minimize noise and habitat impacts.

This alternative would create minimal disturbance throughout the rest of the project area, a result of the presence and activity of work crews. However, because the lynx uses wide swaths of the park, forage areas would be present adjacent to the project and would provide alternate forage areas for individuals along the Colorado River. The work under alternative B would have short-term, minor, adverse impacts on the lynx in the project area by disrupting foraging in the breach area and immediate vicinity. Any effects on the Canada lynx would be perceived on an individual level.

The actions of alternative B would not significantly alter lynx habitat in the breach area. The effects of this alternative on the lynx are limited to human disruption from work in the breach area; therefore, the impacts of alternative B are anticipated to be short-term, negligible to minor, and adverse.

Wolverine. Wolverine habitat is generally characterized by the absence of human presence and development though little is known about the behavioral responses of individual wolverines to human presence, or about the species' ability to tolerate and adapt to repeated disturbance. It is believed, however, that a human presence can affect wolverine denning habits and cause females to abandon natal dens (USFWS 2010). Because zone 1A is not considered suitable denning habitat for the wolverine, it is unlikely that disturbance from work crews and machinery would be an issue. The presence of work crews and machinery would likely deter wolverines from using the area, impacting only movement patterns. Mitigation measures would be implemented to minimize noise and habitat impacts. This would result in a short-term, negligible to minor, adverse effect.

This alternative would create minimal disturbance in the project area, primarily resulting from the presence and activity of work crews. Because of the scarcity of wolverines in the park (one sighting) and because the project area does not support denning habitat, the impacts on the wolverine would be limited to disruption of foraging activity. Similar to the lynx, the wolverine could access adjacent areas to the project area for foraging, thereby minimizing the impacts from the project. The actions under this alternative would not largely affect wolverine habitat.

The actions of alternative B are limited to human disruption from work in the breach area; therefore, the impacts of alternative B are anticipated to be short-term, negligible to minor, and adverse.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife under alternative B would be the same as described for alternative A; long-term, regional, moderate, and beneficial. Parkwide, these special status species populations are affected most predominantly by habitat alterations that are creating adverse effects, but the other management and conservation plans are primarily designed to address these effects.

The impacts from alternative B are local and range from short- to long-term and adverse to beneficial. Under alternative B, adverse effects stem primarily from the disturbance to the species caused by restoration activities and work crews in the project area, and are short-term, local, negligible to minor and adverse. The restoration work would result in long-term, negligible to minor, beneficial effects for the boreal toad, wood frog, Colorado River cutthroat trout, and river otter. These benefits would be a result of habitat improvements in the project area that would encourage further habitation of the area. Combined, the cumulative impact from alternative B and past, present, and future projects would be long-term, moderate, and beneficial. While other plans would generally benefit the species on a larger scale, the habitat within the project area would be improved for four species with the only adverse effects resulting from short-term restoration activities.

Conclusion

Relative to alternative A, alternative B would have the following effects on special-status species in the project area. The presence of work crews in the project area and the restoration actions conducted under alternative B would have local, short-term, and negligible to minor adverse impacts on all special status species with the exception of the Colorado River cutthroat trout. The actions of the alternative would create a disturbance and serve as a deterrent to these species using the area; however, these effects would only occur during the restoration work.

Both the boreal toad and the wood frog would experience long-term, minor benefits from alternative B as a result of the reduction of sediment and debris flowing into Lulu City. Additionally, revegetation and restoration of riparian and wetland habitats throughout the project would benefit these species. The removal of sediment and debris from the Colorado River and the stabilization of its banks would have a negligible to minor benefit the Colorado River cutthroat trout and river otter over the long-term by improving water quality and habitat. Because the project area only represents a limited portion of the trout's habitat, impacts from the project would be primarily felt by the local population of Colorado River cutthroat trout. The actions of alternative B would not significantly alter lynx or wolverine habitat in the breach area.

The cumulative effects from alternative B and past, present, and future projects would be long term, moderate, and beneficial.

IMPACTS OF ALTERNATIVE C – HIGH RESTORATION

This alternative would involve more intensive management actions over large portions of the impacted area. This alternative would focus actions on areas that are unstable and present a high to moderate potential of continued degradation of existing ecosystem resources and services. Restoration methods would be used to stabilize banks, slopes, and disturbed areas; to improve channel stability in portions of Lulu Creek and the Colorado River; and to lessen the availability of breach debris and sediments to the system. This alternative would actively restore the hydrologic conditions in large portions of the impacted area by removing sediment from the 2003 breach or as necessary to restore hydrologic conditions, creating and enhancing step pools and pool-riffle complexes, and reconnecting the Colorado River with the floodplain in localized areas. This alternative would involve the use of heavy equipment and possibly reusing excavated debris for restoration and stabilization actions both within and between zones.

Analysis

Boreal Toad. While there are no known individuals within the project, restoration activities under alternative C could serve as a deterrent to the boreal toad in the project area, particularly in zone 4, which supports potential breeding habitat (NPS 2009). Because this alternative utilizes mechanized equipment for restoration work, the impacts on the boreal toad from restoration activities would be more widespread and intense than those in alternative B. The noise and temporary habitat alterations that would occur from restoration activities, primarily the large equipment used and the scope of restoration activities would represent a localized, short-term, minor, adverse impact on the boreal toad. The impacts from restoration activities are deemed minor because recent toad surveys of the project areas identified no individuals and only minimal potential habitat within the project area. Though the activity would act as a deterrent to any individuals, there is not a current population known in the project area that would be displaced as a result of actions under alternative C.

The restoration work performed under this alternative would substantially alter the current landscape, particularly in zones 3 and 4 where the boreal toad has historically been observed, and where it would be expected to occur. This alternative would enhance the wetland and floodplain functions in and immediately upstream of the Lulu City wetland, and the re-establishment of the Colorado River into its historical channel would help to restore the hydrology of the area to pre-breach conditions. Additionally, throughout the zones, upland slopes would be revegetated. Stabilized and removed sediment would reduce the amount of debris that could be released over time and that could adversely affect wetland toad habitat. Sedimentation in the project area affects local hydrology and the health of wetlands, which subsequently impacts boreal toad habitat. Some debris would remain such as portions of the Lulu Creek alluvial fan. Combined, these actions would serve to greatly enhance the health of the wetlands and floodplain in the project area. Because boreal toad habitat includes marshes, bogs, and wet meadows, the restoration would represent long-term improvements to toad habitat in the project area. These improvements are anticipated to provide long-term, localized, moderate to major benefits to the boreal toad as restoration expands potential breeding habitat in the project area.

Wood Frog. There are no known individuals within the project area and the nearest known population of wood frogs is approximately 2 miles south of the Lulu City wetland (Scherer 2010). Nevertheless, restoration activities under alternative C could serve as a deterrent to wood frog settlement in the project area during the work, particularly in zone 4 which supports the wetland/wet meadow and stream border habitat that wood frogs are known to utilize. Because this alternative utilizes mechanized equipment for restoration work, the impacts on the boreal toad from restoration activities would be more widespread and intense than those in alternative B. The noise and temporary habitat alterations that would occur from restoration activities, primarily the large equipment used and scope of restoration activities, would represent a short-term, minor adverse impact on the wood frog. The impacts from restoration activities are deemed minor, and not more severe, because recent amphibian surveys did not identify any individuals within the project area. Though the activity would act as a deterrent to any individuals, there is not a current population in the project area that would be displaced as a result of alternative C.

The restoration work performed under this alternative would help to reduce sediment flow into the Lulu City wetland, thereby improving habitat for the frog in the wetland. This alternative would enhance the wetland and floodplain functions immediately upstream of the Lulu City wetland as well, and the re-establishment of the Colorado River into its historical channel would help to restore the hydrology of the area to pre-breach conditions. Stabilized and removed sediment would reduce the amount of debris that could be released over time and that could adversely affect wetland frog habitat. Sedimentation in the project area affects local hydrology and the health of wetlands, which subsequently impacts boreal toad habitat. Some debris would remain such as portions of the Lulu Creek alluvial fan. Combined with the revegetation of upland slopes and the removal of debris throughout the project area, wood frog habitat in the project area would be greatly enhanced. The restoration work conducted under alternative C would improve potential habitat conditions for the wood frog and would have a long-term, moderate to major, beneficial effect on the species.

Colorado River Cutthroat Trout. Under alternative C, adverse effects on the Colorado River cutthroat trout are primarily related to restoration activities and the recontouring of the Colorado River during the course of the implementation. Restoration activities would involve a significant removal and relocation of debris, and these actions would require the use of mechanized equipment. As machinery operates within the river, the level of turbidity and sedimentation in the river would increase. Also, it is possible that the use of mechanized equipment in the river could damage or destroy spawning sites. Actions taken in order to remove sediment and redirect the river into its historical channel would have intense, though temporary, effects on the trout habitat in the project area. Despite these activities, the Colorado River cutthroat trout has habitat beyond the project area and the disturbance would be focused in limited areas and of a limited duration. It is also expected that any harm to the local population would recover within three years. Therefore, the impacts on the Colorado River cutthroat trout from restoration activities under alternative C would be anticipated to be local, short-term, moderate, and adverse.

Alternative C would provide extensive stabilization and debris removal throughout the Colorado River corridor in the project area. The removal of debris and sediment would create long-term improvements to water quality and help to reduce turbidity. Additionally, the restoration of historical hydrologic functions would impact the composition of the stream beds, likely improving spawning habitat for the trout throughout the project area. Restoration activities in zones 2 and 3 would focus on stabilizing the riverbanks and creating step pools to manage stream channel erosion and reduce debris transport and sediment re-suspension, although some debris would remain such as portions of the Lulu Creek alluvial fan. Braided channels would be filled and a single channel configuration would be established. The revegetation along the river would improve the overall riparian habitat of the river, with both direct and indirect benefits to the trout; indirect in that the overall area would be better suited for local wildlife and direct as the river habitat of the trout would be improved and restored. Lastly, the extensive suite of proposed construction and post-construction mitigation measures intended to avoid and minimize adverse effects to trout populations, aquatic habitat for fish, water quality, and streamflow conditions would avoid or minimize impacts to the Colorado River cutthroat trout and other fish species. All of these activities would result in local, long-term, minor to moderate, beneficial impacts on trout habitat. While this alternative would bring extensive changes to the Colorado River in the project area and to the cutthroat trout by extension, the project area represents only a small portion of the trout's habitat in the park and the benefits are primarily limited to the local area, not the greater trout habitat in the park.

River Otter. The disturbance to the river otter under alternative C would be more prolonged and pronounced than that described under alternative B. Restoration activities would involve a significant removal and relocation of debris, and these actions would require the use of mechanized equipment. As machinery operates within the river, the level of turbidity and disturbance in the river would deter wildlife, especially fish which are the primary food source of the otter. Additionally, actions taken in order to redirect the river into its historical channel would have intense, though temporary, effects on otter habitat in the project area. The use of helicopters would expand the area of impact from the project. However, because the project area only represents a small portion of the otter's range in the park, the species would still have sufficient forage areas in other parts of the Colorado River corridor and the Kawuneeche Valley. The work under alternative C would have local, short-term, negligible to minor, adverse impacts on the otter in the project area by disrupting foraging throughout the project area. Any effects on the river otter would likely be perceived by individuals and would not be felt on a population level.

Alternative C would provide extensive stabilization and debris removal throughout the Colorado River corridor in the project area. The removal of debris and sediment would create long-term improvements to water quality and help to reduce turbidity. Restoration activities in zones 2 and 3 would focus on stabilizing the riverbanks and creating step pools to manage stream channel erosion and reduce debris transport and sediment re-suspension, although some debris would remain such as portions of the Lulu Creek alluvial fan. Braided channels would be filled in a single channel configuration would be established. Lastly, the revegetation along the river would improve the overall riparian habitat of the river, with both direct and indirect benefits to the otter. All of these activities would result in local, long-term, negligible to minor, beneficial impacts on river otter habitat in the project area. While this alternative would bring extensive changes to the Colorado River in the project area and to the otter, the project area represents only a small portion of the species' habitat in the park and the benefits are primarily limited to the local area, not the greater habitat in the park.

Canada Lynx. Impacts on the Canada lynx in zone 1A would be the same as described under alternative B and, with mitigation measures to reduce noise and habitat impacts, would be short term and minor adverse.

The disturbance to the Canada lynx under alternative C would be more prolonged and pronounced than that described in alternative B. As a result, the project's area of affect could be larger, largely because of the extended timeframes and louder noise from restoration activities. However, because the breach area only represents a small portion of the lynx's range in the park, the species would still have sufficient forage areas adjacent to the project and in other parts of the park. The work under alternative C would have short-term, negligible to minor, adverse impacts on the lynx in the project area by disrupting foraging in the breach area and the larger area of restoration activity. Any effects on the Canada lynx would likely be perceived by individuals and would not be felt on a population level.

The actions of alternative C would not significantly alter lynx habitat in the project area, but the restoration and stabilization would serve to improve the natural condition and balance of the area. This would indirectly affect the lynx by enhancing forage opportunities throughout the breach area when restoration activities are completed. Therefore, alternative C would also have long-term, negligible to minor, beneficial impacts.

Wolverine. Impacts on the wolverine in zone 1A would be the same as described in alternative B and, with mitigation measures to reduce noise and habitat impacts, would be short term and negligible to minor adverse.

The disturbance to the wolverine under alternative C would be more prolonged and pronounced than that described in alternative B. As a result, the project's area of affect could be larger, largely because of the extended timeframe and louder noise from restoration activities. However, because the project area only represents a small portion of the wolverine's range and because of the scarcity of the species in the park, the work under alternative C would have short-term, negligible to minor, adverse impacts on the wolverine from disrupting foraging in the area of restoration activity. The species would still have sufficient forage areas adjacent to the project and in other parts of the park. Any effects on the wolverine would not be felt on a population level.

The actions of alternative C would not significantly alter wolverine habitat in the project area, but the restoration and stabilization would serve to improve the natural condition and balance of the area. This may indirectly affect the wolverine by enhancing forage opportunities throughout the breach area when restoration activities are completed, though it is not likely to significantly impact the species in this sense. Alternative C would therefore have long-term, negligible to minor, beneficial impacts.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife under alternative C would be the same as described for alternatives A and would be long-term, regional, moderate, and beneficial. Parkwide, these special status species populations are affected most predominantly by habitat alterations that are creating adverse effects, but the other management and conservation plans are primarily designed to address these effects.

Contributions to cumulative impacts under alternative C generally fall into two categories; short-term, local, and adverse and long-term beneficial. Because alternative C utilizes large, mechanized equipment to complete restoration activities, there would be more pronounced adverse effects on local special status species from the actual restoration activity and impacts would be short-term (two years) and ranging from negligible to moderate adverse.

This alternative would restore the natural hydrologic conditions of the project area and would rehabilitate the wetlands in zones 3 and 4. Additionally, this alternative would oversee large tracts of willow revegetation along the Colorado River. Overall, alternative C would result in a long-term, moderate to major, beneficial effect on the habitat in the project area for boreal toad and wood frog, and negligible to minor benefits for Colorado River cutthroat trout and river otter. Both the lynx and the wolverine would experience negligible to minor beneficial effects, albeit indirectly, as forage opportunities and overall habitat health are improved. Combined with past, present, and future projects, the impacts of alternative C would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and special status species habitat in the project area.

Conclusion

Relative to alternative A, alternative C would have the following effects on special status species in the project area. The presence of work crews in the project area and the restoration actions conducted under alternative C would have local, short-term, and negligible to moderate adverse impacts on special status species. The actions of the alternative would create a disturbance and serve as a deterrent to use of the area. However, these effects would only occur for the duration of the work, a period of two to three seasons.

The restoration actions under alternative C would have long-term, moderate to major benefits for the boreal toad and wood frog; minor to moderate benefits for cutthroat trout; and negligible to minor benefits for river otter, Canada lynx, and wolverines in the area. The restoration of the Lulu City wetland and the reestablishment of the Colorado River into its historical channel would help to restore hydrologic conditions to the project area, largely benefiting habitat of the boreal toad and wood frog. Slope stabilization and revegetation throughout the project area would improve water quality and riparian habitats, and extensive willow revegetation would help to establish historical habitat conditions. This would improve habitat for the cutthroat trout and river otter. Overall, these actions would help restore habitat complexity, species diversity, and forage opportunities for lynx and wolverine.

Combined with past, present, and future projects, the impacts of alternative C would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and special status species habitat in the project area.

IMPACTS OF ALTERNATIVE D – THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Analysis

Boreal toad. The disturbance to the boreal toad under alternative D would be similar to that of alternative C. The use of mechanized equipment would generate large local disturbances and temporary habitat alterations in zone 4; however, because of the scarcity of the boreal toad in the project area, these impacts would be limited. As in alternative C, the adverse impacts on the boreal toad would be local, short-term, and minor.

Similar to alternative C, this alternative would redirect the Colorado River into its historical channel and would enhance the wetland and floodplain functions both in and immediately upstream of the Lulu City wetland. The impacts on the toad under alternative D are similar to those described under alternative C. However, the removal and redistribution of more debris from zone 2 under this alternative may improve willow regeneration and water flow in the wetlands and floodplains of the project area and further reduce the amount of debris that could be released over time that could adversely affect toad habitat. The anticipated effects on boreal toad habitat from the restoration in this alternative are therefore long term, moderate to major, and beneficial.

Wood Frog. As with the boreal toad, the adverse effects of alternative D are similar to those of alternative C. The noise and temporary habitat alterations that would occur from restoration activities, primarily a result of the large equipment used and the scope of restoration activities, would represent a short-term, minor adverse impact on the wood frog. However, this disturbance would remain primarily limited to individuals that may occur in the area and there have not been any recent observations of the frog in the project area (Scherer 2010).

Similar to alternative C, this alternative would redirect the Colorado River into its historical channel and would enhance the wetland and floodplain functions both in and immediately upstream of the Lulu City wetland. The impacts on the wood frog under alternative D are similar to those of alternative C. However, the removal and redistribution of more debris from zone 2 under alternative D may improve willow regeneration and water flow in the wetlands and floodplains of the project area and further reduce the amount of debris that could be released over time that could adversely affect wood frog habitat. Bank stabilization and revegetation would help improve stream-side habitats of the frog. The anticipated effects on wood frog habitat from the restoration in this alternative are long term, moderate to major, and beneficial.

Colorado River Cutthroat Trout. Adverse impacts on the Colorado River cutthroat trout under alternative D are similar to those described under alternative C. The removal of debris, the recontouring of the Colorado River channel in zone 4, and the use of mechanized equipment in the river would all have temporary but intense impacts on the trout in the project. The impacts from restoration activity under this alternative would likely be localized, short term, moderate, and adverse.

The benefits to the Colorado River cutthroat trout under alternative D are also similar to those under alternative C. The primary difference as it relates to the trout is that alternative D would result in a large amount of debris removal throughout the project area, particularly from the alluvial fan in zone 2. Under alternative D, restoration activities would focus on the stabilization of riverbanks, revegetation of streamside riparian habitat, the reestablishment of the historical Colorado River channel, and restoration of most pre-breach hydrologic conditions to the project area. An extensive suite of trout protection, water quality, and hydrology mitigation measures would be employed to avoid and minimize the adverse effects of restoration actions. These actions would improve the overall riparian habitat of the river, as well as water quality, and would result in benefits to trout habitat. These benefits would be considered local, long term, and moderate. While this alternative would bring extensive changes to the Colorado River in the project area and to the cutthroat trout by extension, the project area represents only a small portion of the trout's habitat in the park and the benefits are primarily limited to the local area, not the greater trout habitat in the park.

River Otter. Similar to alternative C, adverse impacts on the river otter are primarily a result of restoration activities in and along the Colorado River corridor under alternative D. The use of mechanized equipment and the presence of work crews would serve as a deterrent for the otter in the project area throughout the duration of the project. The reestablishment of the river channel would have acute impacts on the habitat, though only for a short period of time. However, the project area only represents a small portion of the otter habitat along the Colorado River and effects from restoration activity would be temporary. Therefore, the adverse impacts under alternative D would be anticipated to be local, short-term, and negligible to minor. Any effects on the river otter would likely be perceived by individuals and would not be felt on a population level.

The benefits of alternative D are also similar to those described under alternative C. Restoration activities under this alternative would improve the overall riparian habitat of the project area, and seek to restore historical hydrologic functions. These would affect the river otter by improving the broader wildlife habitat in the project area and thereby the ecosystem functions of the area. Improved water quality, reduced turbidity, and the improvement of fish habitat would enhance foraging opportunities for the otter. Overall, alternative D would result in local, long-term, negligible to minor, beneficial impacts on the habitat of the river otter in the project area.

Canada Lynx. Impacts on the Canada lynx in zone 1A would be the same as described in alternative B and, with mitigation measures to reduce noise and habitat impact, would be short term and minor adverse.

The disturbance to the Canada lynx under alternative D would be similar to that of alternative C. Under alternative D the use of mechanized equipment would be slightly less in zone 1B, but the project area as a whole would experience loud noise from restoration activities for a similar timeframe. As is the case with alternative C, the breach area only represents a small portion of the lynx's range in the park and the species would still have sufficient forage areas adjacent to the project and in other parts of the park. Comparable to alternative C, the work under alternative D would have short-term, negligible to minor, adverse impacts on the lynx in the project area by disrupting foraging in the breach area and the larger area of restoration activity. Any effects on the Canada lynx would likely be perceived by individuals and would not be felt on a population level.

The actions of alternative D would not significantly alter lynx habitat in the project area, but the restoration and stabilization would serve to improve the natural condition and balance of the area. This would indirectly affect the lynx by enhancing forage opportunities throughout the breach area when restoration activities are completed. Therefore, alternative D would also have long-term, negligible to minor, beneficial impacts.

Wolverine. Impacts on the wolverine in zone 1A would be the same as described in alternative B and, with mitigation measures to reduce noise and habitat impact, would be short term, negligible to minor, and adverse.

The disturbance to the wolverine under alternative D would be similar to that described under alternative C. Under alternative D the use of mechanized equipment would be slightly less in zone 1B, but the breach area as a whole would experience loud noise from restoration activities for a similar timeframe. Because the project area only represents a small portion of the wolverine's range, and because of the scarcity of the species in the park, the work under alternative D would have short-term, negligible to minor, and adverse impacts on the wolverine through disruption of foraging behavior in the breach area and the larger area of restoration activity. The species would still have sufficient forage areas adjacent to the project and in other parts of the park. Any effects on the wolverine would not be felt on a population level.

The actions of alternative D would not significantly alter wolverine habitat in the breach area, but the restoration and stabilization would serve to improve the natural condition and balance of the area. This may indirectly affect the wolverine by enhancing forage opportunities throughout the breach area when restoration activities are completed, though it is not likely to significantly impact the species in this sense. Alternative D would also have long-term, negligible to minor, beneficial impacts.

Cumulative Impacts

The existing effects of other plans, projects, and actions on special status species under alternative D would be the same as described for the preceding alternatives and would be long term, regional, moderate, and beneficial. Parkwide, wildlife populations are affected most predominantly by habitat alterations that are creating adverse effects, but the other management and conservation plans are primarily designed to address these effects.

The impacts under alternative D generally fall into two categories; short term, local, and adverse and long term beneficial. Overall, the effects of alternative D are very similar to those described under alternative C. Large, mechanized equipment used for the restoration activities would result in local, short-term, and negligible to moderate adverse effects on special status species from restoration activities. The presence of work crews over two seasons would also negatively impact wildlife in the area.

Beneficial effects would result from the restoration conducted under alternative D. This alternative would restore the natural hydrologic conditions of the project area and would rehabilitate the wetlands in zones 3 and 4. Additionally, this alternative would oversee large tracts of willow revegetation along the Colorado River. Overall, alternative D would result in a long-term, moderate to major, beneficial effect on the habitat in the project area for boreal toad and wood frog; moderate benefit for Colorado River cutthroat trout; and negligible to minor benefit for the river otter. Both the lynx and the wolverine would experience negligible to minor beneficial effects, albeit indirectly, as forage opportunities and overall habitat health are improved. Combined with past, present, and future projects, the impacts of alternative D would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and special status species habitat in the project area.

Conclusion

Relative to alternative A, this alternative would have the following effects on special status species in the project area. The presence of work crews in the project area and the restoration actions conducted under alternative D would have local, short-term, and negligible to moderate adverse impacts on special status species. The actions of the alternative would create a disturbance and serve as a deterrent to use of the area. This disturbance would be greater than under alternative B because this alternative would utilize large, mechanized equipment which would generate more noise over a larger footprint. However, these effects would only be felt during the duration of the work, a period of two to three seasons.

Similar to alternative C, the restoration actions under alternative D would have long-term, moderate to major benefits for the boreal toad and wood frog; moderate benefits for cutthroat trout; and negligible to minor benefits for river otter, Canada lynx, and wolverines in the area. The restoration of the Lulu City wetland and the reestablishment of the Colorado River into its historical channel would help to restore hydrologic conditions to the project area, benefiting habitat of the boreal toad and wood frog. Slope stabilization, revegetation throughout the project area, and removal of debris from the alluvial fan in zone 2 would improve water quality and riparian habitats, and extensive willow revegetation would help to establish historical habitat conditions. This would improve habitat for the cutthroat trout and river otter. Overall, these actions would help restore habitat complexity, species diversity, and forage opportunities for lynx and wolverine.

Combined with past, present, and future projects, the impacts of alternative D would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and special status species habitat in the project area.

IMPACTS OF ALTERNATIVE E – MAXIMUM RESTORATION

This alternative would involve an extensive level of management activity and use of motorized equipment over large portions of the impacted area to restore the project area to reflect both pre-breach and desired historical conditions. Streambanks and slopes would be recontoured and stabilized to approximate pre-breach contours to reduce release and transport of sediments over a larger portion of the impacted area. Extensive changes would be made to both the existing and historical Colorado River channels to route the river to its historical alignment through the center of the Lulu City wetland. This alternative would actively restore the hydrologic conditions by removing debris deposits resulting from the 2003 breach and additional historical human-caused deposits. Debris would be reused in the restoration and stabilization actions both within and between zones. This alternative would involve extensive use of heavy mechanized equipment throughout the impacted area.

Analysis

Boreal Toad. Under alternative E, the use of mechanized equipment would generate large local disturbances and temporary habitat alterations in zone 4; however, because of the scarcity of the boreal toad in the project area, these impacts would be limited. This alternative would introduce a staging/haul road in zones 3 and 4 that would be used for transporting excavated debris and the anticipated scope of work would increase to three years, as opposed to two in the other action alternatives. While the duration of the project would still qualify as a short-term impact, the additional year would create a larger impact on the toad. As a result, the impacts on the boreal toad from restoration activities under this alternative would be considered short-term, adverse, and minor to moderate.

Similar to alternatives C and D, this alternative would redirect the Colorado River into its historical channel and would enhance the wetland and floodplain functions both in and immediately upstream of the Lulu City wetland. The impacts on the toad under alternative E are similar to those of alternative D, though with slightly more removal and redistribution of debris from zones 2 and 4. This may improve willow regeneration and water flow in the wetlands and floodplains of the project area. The anticipated effects on boreal toad habitat from the restoration in this alternative are long term, moderate to major, and beneficial.

Wood Frog. The impacts on the wood frog under alternative E would be similar to the boreal toad. The use of large mechanized equipment, a staging/haul road, and an expected restoration period of three years would result in short-term, adverse, and minor to moderate impacts on the wood frog from the anticipated restoration activities under alternative E.

Similar to alternatives C and D, this alternative would redirect the Colorado River into its historical channel and would enhance the wetland and floodplain functions both in and immediately upstream of the Lulu City wetland. The impacts on the wood frog under alternative E would be similar to those described under alternative D, though with slightly more removal and redistribution of debris from zones 2 and 4. This may improve willow regeneration and water flow in the wetlands and floodplains of the project area. The anticipated effects on wood frog habitat from the restoration in this alternative are long term, moderate to major, and beneficial.

Colorado River Cutthroat Trout. Adverse impacts on the Colorado River cutthroat trout under alternative E are similar to those in alternatives C and D. The removal of large amounts of debris, extensive recontouring to stabilize slopes and banks within the project area, and the use of mechanized equipment in the river would all have temporary but intense impacts on the trout in the project. The impacts from restoration activity under this alternative would likely be localized, short-term, moderate, and adverse.

The long-term benefits to the Colorado River cutthroat trout under alternative E are also similar to those described under alternative D. The primary difference as it relates to the trout is that alternative E would oversee a larger amount of debris removal. An extensive suite of trout protection, water quality, and hydrology mitigation measures would be employed to avoid and minimize the adverse effects of restoration actions. Under this alternative, restorations activities would improve the overall riparian habitat of the river, as well as water quality, and would result in both indirect and direct benefits to trout habitat; indirect in that the overall area would be better suited for local wildlife; and direct in that the river habitat of the trout would be improved and restored. These benefits would be considered localized, long term, and moderate. While this alternative would bring extensive changes to the Colorado River in the project area and to the cutthroat trout by extension, the project area represents only a small portion of the trout's habitat in the park and the benefits are primarily limited to the local area, not the greater trout habitat in the park.

River Otter. Adverse impacts on the river otter under alternative E would be similar to those described under alternatives C and D. The use of mechanized equipment and the presence of work crews would serve as a deterrent for the otter in the project area throughout the duration of the project. The reestablishment of the river channel to its historical location would have acute impacts on the habitat, though only for a short period of time. In addition to these impacts, alternative E would also have a staging/haul road that would increase activity in the project area and extend the duration of the project to three years. With these additional actions, the adverse impacts would be slightly more noticeable and would be local, short-term, and negligible to minor. Any effects on the river otter would likely be perceived by individuals and would not be felt on a population level.

The long-term benefits of alternative E would also be similar to those described under alternatives C and D. Restoration activities in this alternative would improve the overall riparian habitat of the project area, and this alternative seeks to restore historical hydrologic functions. These would indirectly affect the river otter by improving the broader wildlife habitat in the project area and thereby the ecosystem functions of the area. Direct impacts would include improved water quality, reduced turbidity, and the improvement of fish habitat that would enhance foraging opportunities for the otter. Overall, alternative E would result in local, long-term, negligible to minor, beneficial impacts on the habitat of the river otter in the project area.

Canada Lynx. Impacts on the Canada lynx in zone 1A would be the same as described under alternative B and with, mitigation measures to reduce noise and habitat impacts, would be short term, minor, and adverse.

The disturbance to the Canada lynx under alternative E would be similar to that described under alternative C. However, under alternative E, the project area would experience similar loud noise from restoration activities and the use of mechanized equipment for an additional work season. As is the case with alternative C, the breach area only represents a small portion of the lynx's range in the park and the species would still have sufficient forage areas adjacent to the project and in other parts of the park. Comparable to alternative C, the work under alternative E would have short-term, negligible to minor, adverse impacts on the lynx in the project area by disrupting foraging in the breach area and the larger area of restoration activity. Any effects on the Canada lynx would likely be perceived by individuals and would not be felt on a population level.

The actions of alternative E would not significantly alter lynx habitat in the project area, but restoration and stabilization would serve to improve the natural condition and balance of the area. This would indirectly affect the lynx by enhancing forage opportunities throughout the project area when restoration activities were completed. Therefore, alternative E would also have long-term, negligible to minor, beneficial impacts.

Wolverine. Impacts on the wolverine in zone 1A would be the same as described under alternative B and would be short-term, negligible to minor adverse. Mitigation measures would be implemented to minimize noise and habitat impacts.

The disturbance to the wolverine under alternative E would be similar to those described under alternative C. However, under alternative E, the project area as a whole would experience loud noise from restoration activities and the use of mechanized equipment for an additional work season. Because the breach area only represents a small portion of the wolverine's range, and because of the scarcity of the species in the park, restoration under alternative E would have short-term, negligible to minor, adverse impacts on the wolverine from disruption of foraging behavior in area of restoration activity. The species would still have sufficient forage areas adjacent to the project and in other parts of the park. Any effects on the wolverine would not be felt on a population level.

The actions of alternative E would not significantly alter wolverine habitat in the project area, but the restoration and stabilization would serve to improve the natural condition and balance of the area. This may indirectly affect the wolverine by enhancing forage opportunities throughout the project area when restoration activities are completed, though it is not likely to significantly impact the species in this sense. Alternative D would also have long-term, negligible to minor, beneficial impacts.

Cumulative Impacts

The existing effects of other plans, projects, and actions on special status species under alternative E would be the same as described for the preceding alternatives and would be long-term, regional, and beneficial. Parkwide, these special status species populations are affected most predominantly by habitat alterations that are creating adverse effects, but the other management and conservation plans are primarily designed to address these effects.

The impacts under alternative E generally fall into two categories; short term, local, and adverse and long term beneficial. Overall, the cumulative effects of alternative E are very similar to those described under alternatives C and D. Large, mechanized equipment used for the restoration activities would result in local, short-term, and negligible to moderate adverse effects on special status species from restoration activities. The adverse effects under alternative E would be incrementally greater than under alternatives C and D because of the larger area of impact created by the staging/haul road and also the longer duration of restoration activities over three seasons.

This alternative would restore the natural hydrologic conditions of the project area and would rehabilitate the wetlands in zones 3 and 4. Additionally, this alternative would oversee large tracts of willow revegetation along the Colorado River. Overall, alternative E would result in a long-term, moderate to major, beneficial effect on the habitat in the project area for boreal toad and wood frog; moderate benefits for Colorado River cutthroat trout; and negligible to minor benefits for river otter. Both the lynx and the wolverine would experience long-term, negligible to minor, beneficial effects, albeit indirectly, as forage opportunities and overall habitat health were improved. Because alternative E would redistribute more sediment to streamside terraces, it is anticipated that willow communities would benefit more, so the beneficial impact on special status species would be incrementally greater under this alternative as a result of a more robust willow community in the project area. Combined with past, present, and future projects, the impacts of alternative E would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and special status species habitat in the project area.

Conclusion

Similar to alternatives C and D, the restoration actions under alternative E would have long-term, moderate to major benefits for the boreal toad and wood frog; moderate benefits for cutthroat trout; and negligible to minor benefits for river otter, Canada lynx, and wolverines in the area. The restoration actions conducted under alternative E would have local, short-term, and negligible to moderate adverse impacts on special status species. The actions of this alternative would create a disturbance and serve as a deterrent to use of the area. This disturbance would be greater than under alternatives C and D because this alternative would utilize a staging/haul road which would result in a larger footprint. Additionally, this alternative would be conducted over the course of three seasons, as opposed to two.

Similar to alternatives C and D, the restoration actions under alternative E would have long-term benefits for all special status species in the area. The restoration of the Lulu City wetland and the reestablishment of the Colorado River into its historical channel would help to restore hydrologic conditions to the project area, benefiting habitat of the boreal toad and wood frog. Slope stabilization and revegetation throughout the project area would improve water quality and riparian habitats, and extensive willow revegetation would help to establish historical habitat conditions. This would improve habitat for the cutthroat trout and river otter. Overall, these actions would help restore habitat complexity, species diversity, and forage opportunities for lynx and wolverine.

Combined with past, present, and future projects, the impacts of alternative E would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and special status species habitat in the project area.

WILDLIFE

REGULATIONS, GUIDANCE, AND POLICIES

National Park Service Organic Act and Management Policies

The NPS Organic Act and *Management Policies* (NPS 2006a) provide the basis for resource protection, conservation, and management and are fully described in chapter 1, Purpose and Need.

Director's Order #12: Conservation Planning, Environmental Impact Analysis, and Decision-making

Director's Order #12 and Handbook: Conservation Planning, Environmental Impact Analysis and Decision-Making (NPS 2001c) offers the guidance to analyze the potential impacts of the alternatives and to prepare the environmental impact statement.

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act of 1934, as amended, requires consultation with the U.S. Fish and Wildlife Service and the fish and wildlife agencies of states to prevent "loss of and damage to wildlife resources." A key point of this act is that it pertains to water resource modification projects as described by the following:

> The Act provides that whenever the waters or channel of a body of water are modified by a department or agency of the U.S., the department or agency first shall consult with the U.S. Fish and Wildlife Service and with the head of the agency exercising administration over the wildlife resources of the state where construction will occur, with a view to the conservation of wildlife resources.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918, as amended, prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests except as authorized under a valid permit (50 CFR 21.11). Additionally, the act authorizes and directs the Secretary of the Interior to determine if, and by what means, the take of migratory birds should be allowed and to adopt suitable regulations permitting and governing take (for example, hunting seasons for ducks and geese). "Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb.

Migratory Bird Conservation Act

The Migratory Bird Conservation Act of 1934 establishes a Migratory Bird Conservation Commission to approve areas of land or water recommended by the Secretary of the Interior for acquisition as reservations for migratory birds. Consultation with state and local government is required before acquisition.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act of 1940, as amended, provides for the protection of the bald eagle and the golden eagle (as amended in 1962) by prohibiting the take, possession, sale, purchase, barter, offer to sell, purchase or barter, transport, export or import, of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit. "Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb.

Fish and Wildlife Act

The Fish and Wildlife Act of 1956, as frequently amended, establishes a comprehensive national fish, shellfish, and wildlife resources policy, with emphasis on the commercial fishing industry but also with a direction to administer the act with regard to the inherent right of every citizen and resident to fish for pleasure, enjoyment, and betterment and to maintain and increase public opportunities for recreational use of fish and wildlife resources.

Fish and Wildlife Conservation Act

The Fish and Wildlife Conservation Act of 1980 authorizes financial and technical assistance to the States for the development, revision, and implementation of conservation plans and programs for nongame fish and wildlife.

National Park Omnibus Management Act

The National Park Omnibus Management Act of 2008 protects more than two million acres of land as Wilderness in nine states; designates over 1,000 miles of wild and scenic rivers; and establishes three new national parks, three national conservation areas, four national trails, 10 national heritage areas, and a new national monument. It also creates several water conservation, habitat restoration, and land management programs, and gives formal recognition to the 26 million-acre national landscape conservation system established in 2000 to encompass the Bureau of Land Management's national monuments, conservation areas, wilderness and wilderness study areas, wild and scenic rivers, and scenic and historic trails.

Consolidated Natural Resources Act

The Consolidated Natural Resources Act of 2008 authorized certain programs and activities in the Department of the Interior, the Forest Service, and the Department of Energy to implement further the act approving the Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union with the United States of America, to amend the Compact of Free Association Amendments Act of 2003, and for other purposes.

Executive Order: Responsibilities of Federal Agencies to Protect Migratory Birds

Executive Order No. 13186 directs executive departments and agencies to take certain actions to further implement the Migratory Bird Treaty Act.

METHODS AND ASSUMPTIONS FOR ANALYZING IMPACTS

Geographic Area Evaluated for Impacts

The geographic focus of this analysis is the area of the Upper Kawuneeche Valley impacted by the Grand Ditch breach. Impacts on wildlife are evaluated for each of the zones defined by this environmental impact statement, as shown in figure 1.5, as well as the habitats in the greater Upper Kawuneeche Valley that support these species.

Issues

Issues that were identified during internal and public scoping regarding effects on wildlife from restoration activity in the project area include the following:

- The long-term response of wildlife species' populations to the restoration activities in the project area.
- Changes in species diversity, abundance of wildlife, and biodiversity in the habitats affected by the restoration activities.
- Availability and alteration of habitat for wildlife species within the project area.
- Behavior of wildlife species as a reaction to the existing conditions or the actions associated with any of the alternatives' restoration actions.

Assumptions

The following general assumptions were used to analyze the effects of restoration actions on wildlife populations, distribution, and behavior:

- Work would progress in multiple locations simultaneously.
- Work would be conducted during daylight hours.
- Work would be limited to those months of the year where weather allows for access to the project area, generally during the late spring and summer months.
- Mitigation measures, including species surveys, would be conducted prior to the start of restoration activities to provide a baseline status for wildlife populations.

Assessment Methods

Each alternative was assessed to determine the impacts of the actions on wildlife species. Primary steps for assessing impacts included identifying (1) the location of areas likely to be affected by the proposed alternatives and (2) potential changes in wildlife populations, habitat, or behavior from restoration actions related to the Grand Ditch breach. NPS management of wildlife is not based on single animals but rather focuses on the role of animal populations and species within the ecosystem (NPS 2006a). Therefore, the analysis and thresholds of impact intensity focus predominantly on the effects of management actions at the population level. The National Park Service recognizes that individuals within a population would be affected by management actions, and this is described in the analysis but without an associated intensity of effect. Impacts on individuals are described in the analysis, and those individual effects collectively contribute to population level effects.

To understand the effects of restoration activities on other wildlife, park resource inventories and management plans, scientific literature, and published technical data were consulted to analyze different resource management approaches, in addition to consultation with park resource specialists.

The other plans and projects whose effects could cumulatively combine with the effects of the Grand Ditch breach restoration alternatives were presented in chapter 1. Only plans and projects that would have effects on wildlife within the general geographic area affected by the breach are considered in the assessment of cumulative effects on wildlife. The cumulative effects analyses for each of the alternatives evaluates the effects of the other plans and projects on a particular resource, adds the effects identified by the specific restoration alternative, and then identifies the total cumulative effect, including the degree that the restoration alternative contributes to the overall cumulative effect.

Impact Threshold Definitions

Negligible: Native wildlife species or their habitats would not be affected. Effects could occur to individual animals, but would not be of any measurable consequence to wildlife populations. Mitigation measures would not be required.

Minor: Effects on native species or their habitats would be measurable. Population numbers, structure, and other demographic factors may experience small changes, but the changes would not likely affect population viability. Mitigation may be needed to offset adverse effects. If needed, mitigation would likely succeed.

Moderate: Effects on native species or their habitats would be readily detectable and likely cause changes at the population level. These changes to population characteristics may affect its viability. Mitigation may be needed to offset adverse effects. If needed, mitigation may succeed.

Major: Effects on native species or their habitats would be severe or exceptional, measurable, and would have consequences at the population level. The changes would have an effect on the viability of a species or would affect species composition. Mitigation may be needed to offset adverse effects. If needed, mitigation success would not be guaranteed.

Beneficial effects would cause wildlife populations or their habitats to experience improvements toward reference conditions with respect to size, density, and other population characteristics.

Adverse effects would cause wildlife populations or their habitats to experience negative effects with respect to size, density, and other population characteristics.

Short-term: Effects would cease within three years following implementation of the action.

Long-term: Effects would extend more than three years beyond implementation of a restoration action.

IMPACTS OF ALTERNATIVE A – NO ACTION / CONTINUE CURRENT MANAGEMENT

Analysis

Alternative A would involve the continuation of current management of the area impacted by the 2003 Grand Ditch breach. Alternative A represents current conditions and is therefore the baseline against which the action alternatives are compared.

The National Park Service would continue current management of the impacted area, following existing management policies and NPS guidance. The park would not undertake any active restoration but would continue to rely on natural processes to restore the hydrologic conditions and biotic integrity of the area.

Ungulates. Elk, moose, and mule deer are all known to occur in the project area, and bighorn sheep may be transient visitors. For all four ungulate species, the project area represents only a small portion of their habitat within the park (NPS 1970). Because ungulates are mobile species using large areas, adverse impacts on habitat in the project area would be minimal when viewed as a proportion of their ranges. As a result, continuation of current conditions in the project area under the no action alternative would have no impact on the ungulate species that use the Kawuneeche Valley.

Birds. Numerous bird species occupy and utilize the Kawuneeche Valley, from songbirds to scavengers and raptors (Connor 1993). The continued conversion of wetland habitats to sedge wetlands would reduce habitat complexity for songbirds, and the degraded riparian habitat throughout the project area would also affect a variety of birds. However, different bird species utilize a variety of habitats, including willow habitats of varying size and density (Leukering and Carter 1999), and the still-functioning ecosystem in the project area would continue to support birds of all kinds. Alternative A would have local, long-term, and negligible to moderate adverse impacts on birds as a result of reduced habitat complexity stemming from impacts from the 2003 breach. The impact intensity would vary according to species. Songbirds would likely experience greater adverse effects than raptors because diverse wetland communities, such as tall willow complexes would provide habitat for a greater number of songbird species.

Small to Medium-Sized Mammals. Small- to medium-sized mammals in the park are found in a variety of habitats, including wetlands and riparian habitats within the project area (Schulz and Leininger 1991). The continued conversion of wetlands into sedge communities would impact the composition of small mammals in the project area, but because of the variety of habitats throughout the Kawuneeche Valley and even within the project area, the effects on small mammals would be anticipated to be local, long-term, minor, and adverse.

Beavers, a potential keystone species in wetland habitats like zone 4, have a historical presence in the Kawuneeche Valley, though the most recent population survey did not record any observations in 2010 (Scherer et al. 2011). A 2009 survey identified two beaver occupancy locations in the Red Mountain area, south of the project area. The decline of willow communities throughout the park has had a profound effect on the beaver population (Baker et al. 2005), and the same is true for the project area. The Grand Ditch breach created sediment and debris build-ups that have negatively impacted willow communities in the project area. Combined with the continued conversion of wetland habitats to sedge communities, potential beaver habitat in the project area is on the decline. The continuation of current conditions in the project area would represent a local, long-term, and moderate adverse effect on beavers.

Predators and Scavengers. Most predators and scavengers use a variety of forested habitats and would be expected to occur throughout the Kawuneeche Valley, including the project area. Most large predators and scavengers tend to inhabit large ranges (Noss et al. 1996) and would likely be transitory through the project area. Because the project area only represents a small foraging area within the Kawuneeche Valley, there would be no impacts on predators and scavengers under alternative A.

Amphibians and Reptiles. The buildup of sediment and debris from the Grand Ditch breach has adversely impacted the health of the wetlands and has altered the hydrology in the project area. As the hydrology changes in the project area and some wetlands transition to dry meadows and other habitats, the habitat for amphibians and reptiles would continue to be fragmented and habitat availability would decrease (Corn, Jennings, and Muths 1997; Scherer 2010). The no action alternative would not remove any of the debris or sediment deposits upstream from wetland habitats in zone 4. This would enable future downstream transport of debris and sediment and adverse effects would occur as debris and sediment deposition impacted amphibian and reptile habitats. As a result, the adverse impacts on reptiles, and particularly amphibians under current management, would be local and long-term, and minor.

Fish. Sedimentation, scouring, and debris build up in the project area have all occurred as a result of the Grand Ditch breach. Continued scouring and sedimentation are anticipated during high flow events when debris is eroded from deposits in Lulu Creek, the Lulu Creek alluvial fan, and the Colorado River. During such events, fish habitat in the project area would be adversely impacted. High flow events would have the greatest impact on fish habitat, though these would generally be short-term occurrences (Wenger et al. 2011). However, because they typically occur annually, the impacts would be considered long-term. Segments of the Colorado River have morphed into braided channels as a result of sedimentation and debris flow, yet despite the changes to the river, fish are still present both in the single channel and the braided channels. As was summarized previously in the affected environment discussion, 2010 brook trout and Colorado River cutthroat trout populations in the Colorado River, both upstream of and within the Lulu City wetland, reflect trout numbers and biomass levels that were the same as or greater than trout numbers and biomass levels before the 2003 breach event. Overall, adverse impacts on fish (predominantly brook trout) under alternative A are expected to be local, long term, and negligible to minor.

Macroinvertebrates. The continuation of the current hydrologic conditions and sediment movement in the project area would result in wetlands changing to a predominantly sedge structure. Additionally, some wetlands may transition to more upland habitat. These changes would alter the species composition of the terrestrial invertebrates in the project area and would likely reduce overall species diversity as wetland habitat diversity is lost. Overall, this would create a long-term, local, minor to moderate adverse effect on the macroinvertebrate population.

Aquatic invertebrates in the project area would be particularly impacted during and immediately after high flow events that would erode debris deposits in Lulu Creek and the alluvial fan and alter micro-habitats including local hydrology and stream bottom substrate. Flushing of sediments, resulting from high flow events, would cause a change in the abundance of aquatic invertebrates and their community structure (Wellnitz et al. 2001). A sudden release of sediments into a riparian system may cause pool infilling, alteration of channel-bed substrate, an increase in tributary mouth deposits, aggradation of the ecosystem, and loss of water conveyance. Ultimately, the changes in channel morphology would likely result in adverse impacts on the macroinvertebrate community and their habitat (Rathburn and Wohl 2003).

Under alternative A, these high flow occurrences are expected to be more impactful because the stream channels are less defined as a result of sediment and debris buildup. Aquatic communities are known to recover rapidly after disturbances, however, and the effects would be local, short term, and minor to moderately adverse. These impacts may progress to a lesser degree of impact as the hydrologic system stabilized over the course of many years.

Cumulative Impacts

In recent years, low-flying commercial air tours over the park and the use of snowmobiles on Trail Ridge Road have been banned. Wildlife vary in their responses to noises, but loud noise can negatively affect many species through changes in behavior and physiological effects (USAF and USFWS 1988). These bans represent a long-term, regional, minor, beneficial effect for wildlife.

A number of actions in the park and on adjacent lands are targeted on improving forest health by controlling the pine bark beetle and managing forest fuels through mechanical thinning and prescribed fire. These actions are detailed in plans such as the Rocky Mountain National Park Fire Management and the Bark Beetle Management Plan, among others. These activities would adversely affect wildlife as a result of temporary displacement and short-term alteration of wildlife habitat, representing a short-term, minor, adverse effect. With mitigation measures in place, some, but not all, snags would be left in place for cavity nesters, resulting in a long-term, minor, adverse effect. However, overall, these actions would result in long-term, minor to moderate, beneficial effects on wildlife as a result of improved habitat.

A series of construction and trail projects (Trails Management Plan and the Trail System Maintenance and Reconstruction Plan) would temporarily displace wildlife and permanently remove relatively small portions of habitat. The effects of these projects would be both short term, minor, and adverse and long term, negligible, and adverse.

Management plans for protecting the park's natural resources would benefit wildlife, by maintaining and restoring natural conditions and limiting intrusive activities. Effects associated with these management plans would be long term and beneficial. Restoring vegetative communities and removing exotic plants in the park (Invasive Exotic Plant Management Plan, Vegetation Restoration Management Plan) would also enhance wildlife habitat, resulting in a long-term, minor to moderate, beneficial effect on wildlife. Although some bird species may use exotic plant species including songbird use of thistle seed for example, the control of exotic plant species would restore ecosystem integrity and provide a cumulative benefit. The Elk and Vegetation Management Plan is intended to limit the elk population and restore native vegetation, particularly willow and aspen communities. The plan would have long-term, parkwide, moderate benefits on other wildlife species.

Restoration of a native fish species in the park would reduce non-native species and enhance aquatic habitats in the long term, a moderate benefit, but would also potentially involve the use of piscicides, which could remove aquatic life in short reaches of streams, resulting in a short-term, moderate, adverse effect. Efforts to restore the Colorado River cutthroat trout (Colorado River Cutthroat Trout Management Plan) would have long-term benefits on species composition in the Colorado River.

Activities outside the park also affect wildlife species within the park, as individuals outside can be part of the same population as those within the park. Development near and around the park would continue to fragment and reduce wildlife habitat outside the park, representing a long-term, regional, moderate to major, adverse effect. Hunting and fishing outside of the park would continue to be managed so that habitat conditions are not degraded by overpopulation of species that may grow in the absence of predators. Game management outside the park would help maintain habitat quality for wildlife populations that share habitat inside and outside the park and would represent a long-term, regional benefits for wildlife. The current State of Colorado conservation strategy for lynx and wolverine, and the planned Colorado State wolf management plan, would have long-term, regional, moderate to major benefits for wildlife by bolstering the health of key ecosystem predator populations.

Overall, the past, present, and future projects that may affect wildlife in Rocky Mountain National Park are anticipated to have long-term, parkwide and regional, moderate, beneficial impacts on wildlife, both within and beyond the Grand Ditch breach project area.

Under alternative A, the effects of the Grand Ditch breach would generally result in long-term, local, minor to moderate, adverse impacts on wildlife within the project area. Combined, the cumulative impact from alternative A and past, present, and future projects would be long term, moderate, and beneficial. Although the habitat within the breach area would still be degraded, with negative effects on wildlife that use the Upper Kawuneeche Valley, the other plans would benefit wildlife on a larger scale.

Conclusion

The continued management of the project area under alternative A would have a number of adverse impacts on fish and wildlife in the Upper Kawuneeche Valley. The adverse impacts are primarily local and long-term in nature and range from negligible to moderate. Given the current hydrologic condition of the project area, remaining debris deposits in Lulu Creek, the Lulu Creek alluvial fan, and the Colorado River corridor are susceptible to high flow events that increase sedimentation and turbidity, deposit debris, and scour the riparian corridor.

The following effects on wildlife are anticipated under this alternative. Beavers in the project area would suffer local, long-term, and moderate adverse effects from the loss of willow and wetland habitats in the breach area. There would be no impact on the ungulate species that occur in the project area. The impacts on birds would vary by species from negligible to moderate adverse, but all impacts would be local and long-term. Songbirds would be expected to suffer more from the habitat loss and degradation than birds of prey. Impacts on small- to medium-sized mammals would be local, long-term, minor, and adverse. There would be no impact on predators and scavengers under alternative A. The loss of wetland habitats anticipated under this alternative would result in minor adverse impacts on amphibians and reptiles. Fish would experience local, long-term, and negligible to minor adverse effects from continuation of current conditions. The loss of wetland habitats and habitat diversity under this alternative would result in local, long-term, minor to moderate adverse effects on terrestrial invertebrates and short-term, minor to moderate impacts on aquatic invertebrates.

Overall, the cumulative impacts on wildlife from alternative A and past, present, and future projects would be long term, moderate, and beneficial. While local pressures resulting from the 2003 Grand Ditch breach and the subsequent habitat degradation would continue to occur, the benefits of other large-scale projects and plans to conserve habitat and protect wildlife would outweigh these localized adverse effects.

IMPACTS OF ALTERNATIVE B – MINIMAL RESTORATION

Analysis

Alternative B would emphasize a smaller scale of management activity to restore portions of the impacted area, compared with the other action alternatives. This alternative would focus actions on areas that are unstable and present a high potential of continued degradation of existing ecosystem resources and services. Management activities would be conducted using hand tools. Actions would be conducted to provide stabilization of limited areas of unstable slopes and banks. Under alternative B, there would be no active management to change the hydrologic conditions, and the National Park Service would instead rely upon natural processes to restore the hydrologic channel stability condition in the stream channels and wetland areas.

Ungulates. The revegetation and slope stabilization conducted under alternative B would have no measurable impact on ungulates in the Kawuneeche Valley. The project area represents a small portion of their foraging range (NPS 1970) and the revegetation efforts would not be on a large enough scale to affect foraging in the area. However, the presence of work crews and the low levels of noise generated during restoration activities would serve as a deterrent to individuals in the area. These impacts would be short term, local, minor, and adverse.

Birds. The restoration activities under alternative B would focus primarily on spot revegetation and stabilization in limited areas of unstable slopes and banks; however, this alternative would do little to restore willow or alter the conversion of wetlands to sedge meadows. Under alternative B, habitat in upland and riparian zones in the project area would be incrementally improved, resulting in local, minor, long-term benefits to bird species that utilize these habitats. However, because this alternative does little to alter the conversion of wetlands into sedge meadows, habitat complexity in zones 3 and 4 would continue to decline. This would reduce habitat availability, especially for songbirds, and would in turn reduce the diversity of species using the area. This represents a localized, long-term, and negligible to moderate adverse impact on bird populations in the project area depending on the bird species. Songbirds would likely experience greater adverse effects than raptors because the project area provides habitat for a greater number of songbird species (Connor 1993) and the adverse effect would disproportionately affect songbirds greater due to their greater numbers.

Small to Medium-Sized Mammals. Alternative B would do little to alter the conversion of wetlands into sedge meadows and similar to alternative A, this would have a local, long-term, minor adverse impact. This would be offset slightly, however, by the improvement to upland and riparian habitats in the project area as a result of revegetation and slope stabilization in unstable areas along the streams in the project area. These improvements would represent a local, long-term, negligible benefit for small mammals.

The restoration activities under alternative B would focus primarily on spot revegetation and stabilization in limited areas of unstable slopes and banks; however, this alternative would do little to restore willows or alter the conversion of wetlands to sedge meadows. As willow communities continue to decline in the project area, habitat for beavers would follow the same trajectory and would continue to be degraded (Baker et al. 2005). This would result in long-term, moderate, adverse effects similar to alternative A. Additionally, the presence of work crews in the project area would produce low levels of noise in the area which would act as a deterrent to beaver occupancy during the period of restoration. However, because 2010 occupancy surveys did not detect any beavers in the Kawuneeche Valley (Scherer et al. 2011), displacement in the project area would be of minimal concern. The adverse effects on beaver, or a potential recovery of the beaver population, would be local, short term, and minor.

Predators and Scavengers. Similar to Alternative A, there would be no impacts on predators and scavengers in the project area as a result of restoration activities. Habitat alterations under alternative B would not affect these species that forage over large areas and which occupy varied habitats (Noss et al. 1996). Activity related to restoration work would likely deter individuals from accessing the project area during periods when restoration activities are underway, but these adverse impacts would be short term and negligible to minor, only impacting individuals that may be in the area.

Amphibians and Reptiles. Similar to alternative A, the transition of wetlands to dry meadows and sedge communities would continue to affect amphibians and reptiles by decreasing habitat in the project area (Corn, Jennings and Muths 1997). These changes would also serve to fragment habitat of these species. Impacts stemming from the decrease of wetlands would be local, long-term, and minor adverse. Alternative B would not remove all of the debris or sediment deposits upstream of the wetland habitats in zone 4. This would enable future downstream transport of debris and sediment and adverse effects would occur as debris and sediment deposition impacted amphibian and reptile habitats. Additional adverse impacts would occur because of the presence of work crews in the project area. This would have local, short-term, minor adverse impacts on individual amphibians and reptiles in the area that may be driven from habitats by the presence of work crews. The restoration and stabilization work under alternative B would help improve the upland and riparian habitats of the project area, and this would have long-term, negligible to minor benefits on amphibian and reptile habitat.

Fish. Long-term, negligible to minor adverse impacts on fish habitat are expected under alternative B for the same reasons presented under alternative A. High flow events would continue to erode debris deposits remaining in Lulu Creek and the Colorado River, resulting in sedimentation, scouring, and debris deposition in the project area. Because high flow events generally occur annually, the impacts would be considered long-term. The small-scale stabilization and revegetation efforts conducted under alternative B would provide negligible to minor benefits to riparian habitats in the project area by helping to somewhat reduce sediment flow and turbidity during normal streamflows. The application of mitigation measures would be limited and proportional to the size and nature of the disturbances created along river and stream channel banks and in wetlands.

Macroinvertebrates. Similar to alternative A, the continuation of the current hydrologic conditions in the project area would result in wetlands changing to a predominantly sedge structure. Additionally, some wetlands may transition to more upland habitat. These changes would alter the species composition of the terrestrial invertebrates in the project area and would likely reduce overall species diversity as wetland habitat diversity is lost (Allan 2004). Overall, this would create a long-term, local, minor to moderate adverse effect. The small-scale revegetation and stabilization efforts under alternative B would have no detectable impacts on terrestrial invertebrates.

Similar to alternative A, impacts on aquatic invertebrates would be localized, short-term, and minor to moderate adverse. These impacts would be mainly related to high flow events and release of sediments from debris deposits in Lulu Creek and the Colorado River, which would affect the community structure and abundance of aquatic invertebrates. These impacts would likely be lessened over many years as the hydrology of the project area stabilized and debris deposits are reduced. The small-scale revegetation and stabilization efforts under alternative B would have no detectable impacts on aquatic invertebrates.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife under alternative B would be the same as described under alternative A and would be long term, parkwide and regional, moderate, and beneficial. Parkwide, wildlife populations are affected most predominantly by habitat alterations that are creating adverse effects, but the other management and conservation plans are primarily designed to address these effects.

The impacts from alternative B are local and range from short- to long-term and adverse to beneficial. The stabilization efforts would help limit sedimentation in aquatic habitats and would have long-term, negligible to minor benefits; however, because the restoration efforts under alternative B focus primarily on slope stabilization and would do little to reduce debris deposits, restore willow, or alter the conversion of wetland habitats to sedge communities, the benefits to wildlife would be minimal. Many of the adverse impacts on wildlife would be the same as alternative A; however, there would be added impacts from the presence of work crews in the project area, which would create additional disturbance. Combined, the cumulative impact from alternative B and past, present, and future projects would be long term, moderate, and beneficial.

Conclusion

Relative to alternative A, this alternative would have the following effects on wildlife resources in the project area. The presence of work crews in the project area and the restoration actions conducted under alternative B would have local, short-term, and negligible to minor adverse impacts on wildlife. The actions of the alternative would create a disturbance and serve as a deterrent to wildlife using the area; however, these effects would only be felt during the duration of the work.

Similar to alternative A, the restoration work under this alternative would address little wetland and hydrologic degradation, which would long-term and range from negligible to moderate adverse impacts on fish and wildlife.

Long-term, negligible to minor benefits to fish and wildlife from alternative B would result from restoration of upland and riparian habitats, and aquatic habitats would benefit from slope stabilization and revegetation that would contribute to improved water quality. The wildlife groups that would experience the most benefits under this alternative would be small- to medium-sized mammals, fish, amphibians, and reptiles.

The cumulative effects from alternative B and past, present, and future projects would be long term, moderate, and beneficial. The contribution of alternative B would be small.

IMPACTS OF ALTERNATIVE C – HIGH RESTORATION

Analysis

This alternative would involve more intensive management actions over large portions of the impacted area. Alternative C would focus actions on areas that are unstable and present a high to moderate potential of continued degradation of existing ecosystem resources and services. Restoration methods would be used to stabilize banks, slopes, and disturbed areas and to lessen the availability of breach debris and sediments to the system. This alternative would actively restore the hydrologic conditions in large portions of the impacted area by removing sediment from the 2003 breach or the equivalent, creating and enhancing step pools, and reconnecting the Colorado River with the floodplain in localized areas. This alternative would involve the use of mechanized equipment and possibly reusing excavated debris for restoration and stabilization actions both within and between zones.

Ungulates. Adverse impacts on ungulates under alternative C would occur because of the displacement and disturbance related to restoration activities and the presence of work crews. The use of mechanized equipment and work crews in the project would enhance this disturbance. Additionally, temporary browsing exclosure fences to prevent foraging and browsing in revegetated areas would limit the forage availability in the project area; however, this only represents a small portion of the forage range in the Kawuneeche Valley and should not disrupt ungulate feeding habits. Overall, restoration activities under alternative C would result in local, short-term, minor adverse effects on ungulate populations in the project area.

Under alternative C, there would be local, long-term, minor to moderate benefits to ungulate populations in the Kawuneeche Valley from the restoration of willow communities in riparian and wetland habitats in the project area. Willow constitutes a large percentage of the diet for both elk and moose (Peinetti, et al. 2002; Newbury et al. 2007), and also provides forage for mule deer. In the long-run once temporary browsing exclosure fences were removed from young vegetation, forage opportunities would be greatly improved for ungulate species.

Birds. Adverse impacts on birds under alternative C would occur because of the displacement and disturbance related to restoration activities and the presence of work crews. The use of mechanized equipment and work crews throughout the project area would enhance this disturbance. However, the project area only represents a small portion of riparian and wetland habitat in the Upper Kawuneeche Valley, so birds should be able to relocate while restoration activities are underway. Overall, restoration activities under alternative C would result in local, short-term, minor adverse effects on bird populations in the project area.

There would be long-term, localized, minor to moderate benefits to birds from the restoration conducted under alternative C. The restoration of large areas of riparian and wetland habitat would increase the habitat complexity, forage opportunities, and cover for numerous bird species. Songbirds in particular would experience a substantial increase in habitat availability in the project area. Raptors and other birds of prey would also experience long-term benefits from restoration due to the increase in prey.

Small to Medium-Sized Mammals. Adverse impacts on small- to medium-sized mammals under alternative C would occur because of the displacement and disturbance related to restoration activities and the presence of work crews. The use of helicopters and the noise from mechanized equipment and work crews in the project would enhance this disturbance. However, this only represents a small portion of the habitat for small mammals in the Kawuneeche Valley and should not displace these species in the long term. Overall, restoration activities under alternative C would result in local, short-term, minor adverse effects on small- and medium-sized mammal populations in the project area.

There would be long-term, localized, moderate benefits to small- and medium-sized mammals (including beaver), from restoration of large areas of riparian and wetland habitat which would increase the habitat complexity, forage opportunities, and cover for numerous species.

Under alternative C, the primary adverse impacts on beaver would be related to local displacement of individuals as a result of restoration activities. However, because 2010 occupancy surveys did not detect any beaver in the Kawuneeche Valley (Scherer et al. 2011), displacement in the project area would be a minimal concern. The adverse effects on beaver, or a potential recovery of the beaver population, would be local, short-term, and minor as a result of disturbance associated with restoration activities.

In contrast, alternative C would enhance the wetland and floodplain functions immediately upstream of the Lulu City wetland, and the reestablishment of the Colorado River into its historical channel would help to restore the hydrology of the area to pre-breach conditions. Additionally, throughout the zones, willow communities would be reestablished which would significantly improve the habitat quality and availability for beavers in the project area. Combined, these actions would serve to enhance the health of the wetlands and floodplain in the project area. The restoration actions under alternative C would have long-term, local, minor to moderate benefits for beavers and their habitat.

Predators and Scavengers. Adverse impacts on predators and scavengers under alternative C would occur because of the displacement and disturbance related to restoration activities and the presence of work crews. The noise from mechanized equipment and work crews in the project would enhance this disturbance. However, this only represents a small portion of the habitat for these species in the Kawuneeche Valley and should not displace these species in the long term. Overall, restoration activities under alternative C would result in local, short-term, negligible to minor adverse effects on predator and scavenger populations in the project area.

Predators and scavengers would experience long-term, local, minor benefits from the restoration in the project area. The restoration of large areas of riparian and wetland habitat would increase the habitat complexity and cover for numerous species which would lead to greater forage opportunities for predators.

Amphibians and Reptiles. Adverse impacts on amphibian and reptile populations under alternative C would occur because of the displacement and disturbance related to restoration activities and the presence of work crews. Because amphibians primarily occur in wetland and habitats, work in these habitats would be particularly disruptive. These impacts would be considered short-term, minor to moderate, and adverse.

Restoration under alternative C would enhance the wetland and floodplain functions immediately upstream of the Lulu City wetland, and the re-establishment of the Colorado River into its historical channel would help to restore the hydrology of the area to pre-breach conditions. Alternative C would remove much, but not all, upstream debris and sediment, thus there would be less potential for downstream sediment transport and turbidity during high flow events compared to alternative A. Additionally, throughout the zones, upland slopes would be revegetated and unstable slopes would be stabilized. Combined, these actions would serve to greatly enhance the health of the wetlands, floodplains, and riparian habitats in the project area, all of which provide habitat for amphibians and reptiles. Amphibian and reptile species would experience local, long-term, moderate to major benefits from this restoration work.

Fish. Under alternative C, adverse effects on fish species in the project area are primarily related to restoration activities and the recontouring of the Colorado River. Restoration activities would involve a significant removal and relocation of debris, and these actions would require the use of mechanized equipment. As mechanized equipment operates within the river and its tributaries, the level of turbidity and sedimentation in the streams would increase. Also, it is possible that the use of mechanized equipment could damage or destroy spawning sites. Actions taken in order to remove sediment and redirect the Colorado River into its historical channel would have intense, though temporary, effects on the fish habitat in the project area. To address these effects, an extensive suite of mitigation measures would be employed to protect fish populations, water quality, stream hydrology, and physical channel configurations, which affect fish habitat and fish populations. Key mitigation measures intended to minimize adverse fish impacts would include capturing, removing, and relocating as many trout as possible in the work areas to nearby stream sections that would remain unaffected; aggressively controlling water turbidity and suspended sediments within work areas to minimize downstream transport; maintaining streamflows around work areas; and ensuring that streamflows downstream of the restoration area are maintained within existing flow characteristics. The anticipated mitigation measures proposed to protect fish are listed with the alternatives. The suite of mitigation measures would be modified for improved effectiveness as more detailed design and engineering specifications are developed.

Downstream effects of construction associated turbidity on fish and aquatic macroinvertebrates would be minimized by the aggressive deployment of sediment and turbidity control measures. Some less intense turbidity could temporarily extend downstream of the sediment removal and channel realignment areas, but given the negligible to minor effects the 2003 breach event had on existing trout populations, the adverse effects to fish from this turbidity would be negligible to minor. It is also expected that any harm to local fish populations would diminish within three years. Therefore, the impacts on fish from restoration activities in alternative C would be anticipated to be local, short-term, moderate, and adverse primarily because fish would be excluded from river and wetland sections during the restoration period.

Under alternative C, the restoration of hydrologic conditions in the project area, particularly in zones 3 and 4, would have long-term, minor to moderate, beneficial impacts on fish populations within the project area. Combined with the reduced sedimentation and restoration of wetland areas, these restoration efforts would improve habitat by establishing new spawning sites; creating pools, riffles, security cover, and other suitable instream habitat; and improving water quality by decreasing sedimentation and turbidity. Riparian habitats across all zones would be improved through the stabilization of unstable slopes, the removal of debris, and the revegetation of riparian corridors, especially with reestablished willow.

Macroinvertebrates. The restoration activities under alternative C would have no detectable impacts on terrestrial invertebrates; however, debris and sediment excavation in the project area would degrade and damage aquatic invertebrate habitat while restoration activities were underway. As a result, local population numbers would decrease and with the newly degraded habitat, impacts would be considered short-term, moderate to major, and adverse. Aquatic invertebrate populations would be expected to recover within three years.

The restoration of large areas of riparian and wetland habitats to tall willow communities would have long-term beneficial impacts on terrestrial invertebrates throughout the project area. Tall willow communities and healthy wetlands would enhance habitat complexity and would lead to an increase in population sizes and diversity of terrestrial invertebrates. It is anticipated that the removal of sediment and debris, the stabilization of riverbanks, and the reestablishment of former hydrologic conditions would enhance the aquatic habitat for invertebrates. These improvements would stem from decreased sedimentation and turbidity, as well as a more varied habitat resulting from revegetation of riparian corridors. Overall, the restoration under alternative C would have long-term, local, minor to moderate, beneficial impacts on both terrestrial and aquatic invertebrates.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife under alternative C would be the same as described for alternative A and would be long term, parkwide and regional, moderate, and beneficial. Parkwide, wildlife populations are affected most predominantly by habitat alterations that are creating adverse effects, but the other management and conservation plans are primarily designed to address these effects.

The impacts under alternative C generally fall into two categories: short term, local, and adverse and long term beneficial. Because alternative C utilizes mechanized equipment for the restoration activities, there would be local, short-term, and negligible to major adverse effects on wildlife from the actual restoration work. The presence of work crews over two seasons would also negatively impact wildlife in the area. Beneficial effects would be local, long term, and minor to major as a result of the restoration of habitat and reduction in sedimentation. Alternative C would restore the natural hydrologic conditions of the project area and would rehabilitate the wetlands in zones 3 and 4. Additionally, this alternative would oversee large tracts of willow revegetation along the Colorado River. Overall, alternative C would result in a long-term beneficial impact on wildlife and their habitat in the project area, despite the short-term adverse effects of restoration activities. Combined with past, present, and future projects, the impacts of alternative C would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and wildlife habitat.

Conclusion

Relative to alternative A, this alternative would have the following effects on wildlife resources in the project area. The presence of work crews in the project area and the restoration actions using large, mechanized equipment that would generate more noise over a large footprint would have local, short-term, and negligible to major adverse impacts on wildlife. However, these effects would only occur during restoration activities, a period of two to three seasons.

The restoration actions under alternative C would have long-term, local, minor to major benefits for fish and wildlife species in the area. Overall, these actions would help restore habitat complexity, instream physical trout habitat, species diversity, and forage opportunities for many species.

Combined with past, present, and future projects, the impacts of alternative C would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and wildlife habitat.

IMPACTS OF ALTERNATIVE D – THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Analysis

This alternative would emphasize the removal of large debris deposits in the alluvial fan area of zone 2 and in the Lulu City wetland, zone 4. Actions would be conducted to provide stabilization of limited areas of unstable slopes and banks. Actions would be taken to remove selected debris deposits to enhance hydrologic conditions and to remove debris sources that could be eroded and transported downstream. The debris deposited in the alluvial fan would be removed; sediment would be removed in localized areas along the Colorado River to reconnect the river with some previously blocked floodplain locations; and sediment from the 2003 breach would be removed to a large degree from the Lulu City wetland. Hydrology through the Lulu City wetland would be restored through the historical central channel through removal of large deposits of debris, while relying on the historical channel to transport river flow.

Ungulates. Despite slight differences in the actions between alternative C and alternative D, impacts on ungulates under this alternative would be anticipated to be the same as alternative C. Restoration activities under alternative D would result in local, short-term, minor adverse effects on ungulate populations in the project area due to displacement and disturbance from restoration activities. Noise from mechanized equipment would deter ungulates from foraging in the area. Ungulate populations would also experience local, long-term, minor to moderate benefits from the restoration of tall willow communities, riparian and wetland habitats.

Birds. Despite slight differences in the actions between alternative C and alternative D, impacts on birds under this alternative would be anticipated to be the same as alternative C. Adverse impacts on birds under alternative D would occur because of the displacement and disturbance related to restoration activities and the presence of work crews. The noise from mechanized equipment and work crews in the project would enhance this disturbance. Adverse effects would be local, short-term, and minor adverse to bird populations in the project area. Bird populations in the project area would also realize local, long-term, minor to moderate benefits from the restoration of large areas of riparian and wetland habitat. Along with the revegetation of willow communities, habitat complexity, forage opportunities, and cover for numerous bird species would be improved under this alternative.

Small to Medium-Sized Mammals. Despite slight differences in the actions between alternative C and alternative D, impacts on small- and medium-sized mammals under this alternative would be anticipated to be the same as alternative C. The presence of work crews and the use of mechanized equipment would create disturbances resulting in local, short-term, and minor adverse effects on small- and medium-sized mammal populations in the project area. The restoration of large areas of riparian and wetland habitat would increase the habitat complexity, forage opportunities, and cover for numerous species. This would result in local, long-term, moderate benefits for small- and medium-sized mammals.

Despite slight differences in the actions between alternative C and alternative D, impacts on the beaver under this alternative would be anticipated to be the same as alternative C. Restoration activities would result in short-term, negligible to minor adverse impacts because they would deter beavers from using the area. The restoration actions would have local, long-term, minor to moderate benefits for beavers, their habitat, and their potential for recovery by improving the wetlands and riparian areas of the project area, and also by reintroducing tall willow communities to much of the project area.

Predators and Scavengers. Despite slight differences in the actions between alternative C and alternative D, impacts on predators and scavengers under this alternative would be anticipated to be the same as alternative C. There would be local, short-term, negligible to minor adverse effects on predator and scavenger populations in the project area as a result of disturbance from restoration actions. Local, long-term, minor benefits would result from the restoration of large areas of riparian and wetland habitat would increase the habitat complexity and cover for numerous species which would lead to greater forage opportunities for predators.

Amphibians and Reptiles. Despite slight differences in the actions between alternative C and alternative D, impacts on amphibians and reptiles under this alternative would be anticipated to be the same as alternative C. There would be local, short-term, minor to moderate adverse effects as a result of disturbance from restoration actions. Local, long-term, moderate to major benefits would result from the restoration of large areas of riparian and wetland habitat, improvements to local hydrology, and the revegetation of tall willow communities.

Fish. Despite slight differences in the actions between alternative C and alternative D, impacts on fish under this alternative would be anticipated to be similar to those described for alternative C. Under alternative D, the impacts on fish from restoration activities in and along streams would be anticipated to be local, short-term, moderate, and adverse because fish would be excluded from river and wetland sections during the restoration period. An extensive suite of trout, streamflow, and water quality protection and mitigation measures would be deployed to avoid and minimize potential water turbidity, suspended sediment transport, and water levels within and downstream of the work areas. Mitigation measures intended to protect water quality and streamflow conditions would also benefit trout and other aquatic species. Trout population mitigation measures would include capturing and relocating as many fish as possible found inside the channel and sediment removal work areas to other stream sections that would be unaffected by restoration activities. The National Park Service would continue to monitor fish populations in conjunction with the U.S. Fish and Wildlife Service's ongoing monitoring within the park. Local, long-term, moderate, beneficial impacts on fish in the project area would result from the restoration of historical hydrologic conditions, the restoration of riparian and wetland habitat, and improved water quality. In particular, the removal and stabilization of debris and sediment within the alluvial fan in zone 2 would reduce greatly sedimentation of downstream habitat used for foraging and spawning by fish.

Macroinvertebrates. Despite slight differences in the actions between alternative C and alternative D, impacts on both terrestrial and aquatic invertebrates under this alternative would be anticipated to be the same as alternative C. There would be no detectable adverse impacts on terrestrial invertebrates under alternative D, though aquatic invertebrates would experience short-term, moderate to major, and adverse effects resulting from restoration activities in aquatic habitats. The restoration of riparian and wetland habitats, combined with revegetation efforts and a high degree of sediment removal, would result in local, long-term, minor to moderate benefits for both terrestrial and aquatic invertebrates.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife under alternative D would be the same as described for alternative A and would be long term, parkwide and regional, moderate, and beneficial. Parkwide, wildlife populations are affected most predominantly by habitat alterations that are creating adverse effects, but the other management and conservation plans are primarily designed to address these effects.

The impacts under alternative D generally fall into two categories: short term, local, and adverse and long term beneficial. Overall, the cumulative effects of alternative D are very similar to those under alternative C. Mechanized equipment, including helicopters, used for the restoration activities would result in local, short-term, and negligible to major adverse effects on wildlife from the actual restoration work. The presence of work crews over two to three seasons would also negatively impact wildlife in the area. Local, long-term, minor to major, beneficial effects would result from the actual restoration. Alternative D would restore the natural hydrologic conditions of the project area and would rehabilitate the wetlands in zones 3 and 4. Additionally, this alternative would result in large areas of willow revegetation along the Colorado River. Overall, alternative D would result in a long-term, minor to major, beneficial impacts on wildlife and their habitat in the project area, despite the short-term adverse effects of restoration activities. Combined, the cumulative impact from alternative D with past, present, and future projects, would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and wildlife habitat.

Conclusion

Relative to alternative A, this alternative would have the following effects on wildlife resources in the project area. The presence of work crews in the project area and the restoration actions conducted under alternative D would have local, short-term, and negligible to major adverse impacts on wildlife. The actions of the alternative would create a disturbance and serve as a deterrent to wildlife using the area as a result of mechanized equipment and helicopters, which would generate more noise over a large footprint. However, these effects would only occur during the restoration activities, a period of two to three seasons.

The restoration actions under alternative D would have local, long-term, minor to major benefits for fish and wildlife species in the area. The restoration of the Lulu City wetland and the reestablishment of the Colorado River into its historical channel would help to restore hydrologic conditions to the project area. Streambank stabilization, removal of large sediment and debris deposits, and revegetation throughout the project area would improve water quality and riparian habitats, and extensive willow revegetation would help to establish historical habitat conditions. Overall, these actions would help restore habitat complexity, species diversity, and forage opportunities for many species.

The cumulative effects from alternative D and from past, present, and future projects would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and fish and wildlife habitat.

IMPACTS OF ALTERNATIVE E – MAXIMUM RESTORATION

Analysis

This alternative would involve an extensive level of management activity and use of motorized equipment over large portions of the impacted area to restore the project area to reflect both pre-breach and desired historical conditions. Streambanks would be stabilized to approximate pre-breach contours and to reduce transport of sediments over a larger portion of the impacted area. Extensive changes would be made to both the existing and historical Colorado River channels to route the river to its historical alignment through the center of the Lulu City wetland. This alternative would actively restore the hydrologic conditions by removing debris deposits resulting from the 2003 breach and additional historical human-caused deposits. Debris would be reused in the restoration and stabilization actions both within and between zones. This alternative would involve extensive use of mechanized equipment throughout the impacted area.

Ungulates. Adverse impacts on ungulates under alternative E would be similar to alternatives C and D, though slightly greater. Adverse impacts would be local, short-term, and minor to moderate adverse. This alternative is slightly more adverse to ungulate populations as a result of the development of a 40-foot wide staging/haul road for large machinery. Though the effects would still be considered short-term, the longer project duration would have more impacts on a population level. The road could lead to greater mechanized activity and noise in the project area.

The long-term, beneficial impacts on ungulates would be similar to those described under alternative D. Alternative E would remove and redistribute more debris into terraces, which is expected to help establish tall willow communities. Healthier willow communities would provide better forage opportunities for ungulates and localized, long-term, minor to moderate benefits for the populations that use the Kawuneeche Valley.

Birds. Similar to the adverse effects on ungulates under alternative E, the development of a staging/haul road would result in incrementally greater hardships for the bird population in the project area than in the preceding alternatives. The adverse effects would be local, short term, and minor to moderate as a result of restoration activity and noise from mechanized equipment. However, the restoration would also result localized, long-term, minor to moderate benefits. The restoration of large areas of upland, riparian, and wetland habitat and the revegetation of tall willow communities would greatly improve bird habitat in the project area, particularly for songbirds. Raptors and birds of prey would also realize benefits with an increased abundance of prey in the area.

Small to Medium-Sized Mammals. Under alternative E, the extended duration of this alternative and the development of a staging/haul road would result in incrementally greater adverse effects on the populations of small- to medium-sized mammals than in the preceding alternatives. These would be a result of a longer timeframe for conducting restoration activities and greater footprint from the staging/haul road. However, adverse impacts would still be considered local, short term and minor. The local, moderate benefits to small mammals under this alternative would be long term as a result of the restoration of large areas of riparian and wetland habitat that would increase the habitat complexity, forage opportunities, and cover for numerous species. Benefits under alternative E would be incrementally greater than in alternatives C and D as a result of anticipated success of the willow communities.

Impacts on the beaver (or the potential for recovery) under this alternative would be anticipated to be similar to alternatives C and D; however, short-term adverse effects would be incrementally greater, though still of minor intensity. Similar to alternatives C and D, the restoration actions would also have local, long-term, minor to moderate benefits for beavers, their habitat, and potential for recovery by improving wetlands and riparian areas and reintroducing tall willow communities to much of the project area. It should be noted that the increased amount of debris removal and redistribution to streamside terraces under alternative E is anticipated to improve the revegetation efforts of willow in the project area and reduce the potential for future transport of sediment into preferred beaver habitat. A healthier willow community would generate more suitable habitat conditions for beavers than in alternatives C and D.

Predators and Scavengers. Under alternative E, the development of a staging/haul road would result in incrementally greater adverse effects on the populations of predators and scavengers than in the preceding alternatives. However, similar to alternatives C and D, they would be local, short-term, and negligible to minor. Local, long-term, minor benefits would result from the restoration of large areas of riparian and wetland habitat would increase the habitat complexity and cover for numerous species which would lead to greater forage opportunities for predators.

Amphibians and Reptiles. Under alternative E, the development of a staging/haul road would result in incrementally greater adverse effects on the populations of amphibians and reptiles than in the preceding alternatives. However, these impacts would still be anticipated to be local, short-term, and minor to moderate adverse as a result of disturbance from restoration actions. Local, long-term, moderate to major benefits would result from the restoration of large areas of riparian and wetland habitat, improvements to local hydrology, and the revegetation of tall willow communities.

Fish. Under alternative E, adverse impacts on fish would be the same as in alternatives C and D and would be local, short term, moderate, and adverse because fish would be excluded from river and wetland sections during the restoration period. Mitigation measures would be deployed to avoid and minimize potential adverse effects to trout and other fish populations, water quality, and streamflow as was described for alternatives C and D. Local, long-term, moderate, beneficial impacts on fish in the project area would result from the restoration of historical hydrologic conditions, the restoration of riparian and wetland habitat, and improved water quality. In particular, the removal and stabilization of debris and sediment within the alluvial fan in zone 2 would reduce greatly sedimentation of downstream habitat used for foraging and spawning by fish. The creation of a series of new step pools in zone 2 and step pools and pool-riffle complexes in zone 3 would result in more beneficial impacts on fish habitat than in alternatives C and D.

Macroinvertebrates. Impacts on terrestrial invertebrates under alternative E would be the same as those described under alternatives C and D. There would be no detectable adverse impacts on terrestrial invertebrates. Adverse impacts on aquatic invertebrates would be the same as described under alternatives C and D: short term, local, and moderate to major as a result of restoration activity in aquatic habitats. Restoration of riparian and wetland habitats, combined with revegetation efforts and sediment removal, would, however, result in long-term, minor to moderate benefits. These benefits to aquatic invertebrates under alternative E would be incrementally greater than those in alternatives C and D because of the creation of new step pools in zone 2 and step pools and pool-riffle complexes in zone 3. Step pools and pool-riffle complexes would improve habitat complexity and availability and would increase species diversity.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife under alternative E would be the same as described for the preceding alternatives and would be long term, parkwide and regional, moderate, and beneficial. Parkwide, wildlife populations are affected most predominantly by habitat alterations that are creating adverse effects, but the other management and conservation plans are primarily designed to address these effects.

The impacts under alternative E generally fall into two categories: short term, local, and adverse and long term beneficial. Because alternative E utilizes large, mechanized equipment for the restoration activities, there would be local, short-term, and negligible to major adverse effects on wildlife from the actual restoration work. The adverse effects under alternative E would be more pronounced than in alternatives C and D because of the larger footprint created by the installation of a staging/haul road. Local, long-term, minor to major, beneficial effects would result from the restoration. Alternative E would restore the natural hydrologic conditions of the project area and would rehabilitate the wetlands in zones 3 and 4. Additionally, this alternative would oversee large tracts of willow revegetation along the Colorado River. In alternative E, the increased of amount of debris and sediment removal from the river and its subsequent deposition in riparian zones would create better conditions for willow health, more so than in alternatives C and D. Overall, alternative E would result in a long-term, minor to major, beneficial impacts on wildlife and their habitat in the project area, despite the short-term, adverse effects of restoration activities. The cumulative effects from alternative E and past, present, and future projects would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and wildlife habitat.

Conclusion

Relative to alternative A, this alternative would have the following effects on wildlife resources in the project area. The presence of work crews in the project area and the restoration actions using large, mechanized equipment, which would generate more noise over a larger footprint under alternative E, would have local, short-term, and negligible to major adverse impacts on wildlife. The actions of the alternative would create a disturbance and serve as a deterrent to wildlife using the area. This disturbance would be greater than in alternative B because this alternative would utilize large, mechanized equipment which would generate more noise over a larger footprint. The development of a staging/haul road to transport material and equipment under this alternative would create more pronounced adverse effects. Though the adverse effects would still be considered short-term, these effects would be extended under this alternative as restoration activity would take place over a period of three seasons.

The restoration actions under alternative E would have long-term, minor to major benefits for wildlife species in the area. The restoration of the Lulu City wetland and the reestablishment of the Colorado River into its historical channel would help to restore hydrologic conditions to the project area. Streambank stabilization and revegetation throughout the project area would improve water quality and riparian habitats, and extensive willow revegetation would help to establish historical habitat conditions. Alternative E would create better conditions for willow health than alternatives C and D due to the removal of an increased of amount of debris and sediment and its subsequent deposition in riparian zones. Overall, these actions would help restore habitat complexity, species diversity, and forage opportunities for a number of species.

The cumulative effects from alternative E and past, present, and future projects would be long term, local and regional, moderate, and beneficial as a result of the concerted effort to restore and rehabilitate important ecosystem functions and fish and wildlife habitat.

CULTURAL RESOURCES

REGULATIONS, GUIDANCE, AND POLICIES

National Historic Preservation Act

Section 106 of the National Historic Preservation Act of 1966 requires federal agencies to consider the effects of their undertakings on properties listed or potentially eligible for listing on the National Register of Historic Places. All actions affecting the parks' cultural resources must comply with this legislation.

National Environmental Policy Act

The National Environmental Policy Act requires analysis of the impacts of federal actions on the human environment (the natural and physical environment and its relationship with human culture); and directs that these important historical, cultural and natural aspects of our national heritage be preserved.

Director's Order #28: Cultural Resource Management

The physical attributes of cultural resources are, with few exceptions, nonrenewable. Once the historic fabric of a resource is gone, nothing can restore its authenticity or gain information that might have been found through analysis. NPS Director's Order #28 (NPS 1998) provides guidance for management and protection of the cultural resources in National Park Service custody.

METHODS AND ASSUMPTIONS FOR ANALYZING IMPACTS

Geographic Area Evaluated for Impacts

The area of potential effects evaluated for impacts on cultural resources includes those areas within (including zones 1 through 4) and in close proximity to the restoration area within the Upper Kawuneeche Valley.

Issues

One issue related to cultural resources was identified by the National Park Service, other agencies, and the public during internal and public scoping (See chapter 1 for a complete list of identified issues). The Upper Kawuneeche Valley contains numerous cultural resources, and elements of a restoration project involving earth movement could impact archaeological resources and/or historical sites.

Assumptions

The following general assumption was used to analyze the effects of restoration actions on cultural resources:

- If newly discovered sites were identified during restoration activities and could not be avoided, state historic preservation officer concurrence for mitigation would be required.

Assessment Methods

Impacts on cultural resources are described in terms of type, context, duration, and intensity, which is consistent with the regulations of the Council on Environmental Quality that implement the National Environmental Policy Act. Cultural resources are nonrenewable; therefore, adverse impacts on cultural resources would be long-term and extend well beyond implementation of the project.

These impact analyses are intended to comply with the requirements of both the National Environmental Policy Act and Section 106 of the National Historic Preservation Act. In accordance with the Advisory Council on Historic Preservation's regulations implementing Section 106 of the National Historic Preservation Act (36 CFR Part 800, *Protection of Historic Properties*), impacts on cultural resources were identified and evaluated by (1) determining the area of potential effects; (2) identifying cultural resources present in the area of potential effects that are either listed in or eligible to be listed in the National Register of Historic Places; (3) applying the criteria of adverse effect on affected, National Register eligible or listed cultural resources; and (4) considering ways to avoid, minimize or mitigate adverse effects.

Under the Advisory Council's regulations, a determination of either *adverse effect* or *no adverse effect* must also be made for affected National Register listed or eligible cultural resources. An *adverse effect* occurs whenever an impact alters, directly or indirectly, any characteristic of a cultural resource that qualifies it for inclusion in the National Register, for example diminishing the integrity (or the extent to which a resource retains its historic appearance) of its location, design, setting, materials, workmanship, feeling, or association. Adverse effects also include reasonably foreseeable effects caused by the alternatives that would occur later in time, be farther removed in distance or be cumulative (36 CFR 800.5, *Assessment of Adverse Effects*). A determination of *no adverse effect* means there is an effect, but the effect would not diminish the characteristics of the cultural resource that qualify it for inclusion in the National Register.

Council on Environmental Quality regulations and the *Director's Order #12 Conservation Planning, Environmental Impact Analysis and Decision Making* also call for a discussion of mitigation, as well as an analysis of how effective the mitigation would be in reducing the intensity of a potential impact, for example reducing the intensity of an impact from major to moderate or minor. Any resultant reduction in intensity of impact due to mitigation, however, is an estimate of the effectiveness of mitigation under the National Environmental Policy Act only. It does not suggest that the level of effect as defined by Section 106 is similarly reduced. Cultural resources are non-renewable resources and adverse effects generally consume, diminish, or destroy the original historic materials or form, resulting in a loss in the integrity of the resource that can never be recovered. Therefore, although actions determined to have an adverse effect under Section 106 may be mitigated, the effect remains adverse.

A Section 106 summary is included under each impact analysis section for historic structures and archeological resources. The Section 106 summary is an assessment of the effect of the undertaking (implementation of the alternative), based upon the criterion of effect and criteria of adverse effect found in the Advisory Council's regulations.

The following discussion correlates the different requirements of National Historic Preservation Act and National Environmental Policy Act to disclose potential effects on cultural resources and to achieve compliance with both laws.

Impact Threshold Definitions for Archeological Resources

Negligible: The effect would be at the lowest level of detection – barely perceptible or measurable. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Minor: The action would affect an archeological site(s) with modest data potential and no significant ties to a living community's cultural identity. The determination of effect for Section 106 would be *no adverse effect*.

Moderate: The action would affect an archeological site(s) with high data potential and no significant ties to a living community's cultural identity. The determination of effect for Section 106 would be *adverse effect*.

Major: The action would affect an archeological site(s) with exceptional data potential or that has significant ties to a living community's cultural identity. The determination of effect for Section 106 would be *adverse effect*.

Beneficial effects would preserve and protect the integrity of cultural resources.

Adverse effects would damage or diminish the integrity of cultural resources.

Long-term: Any effects on cultural resources would be long-term because these resources are non-renewable.

Impact Threshold Definitions for Historic Structures

Negligible: The effect would be at the lowest level of detection – barely perceptible or measurable. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Minor: The action would not affect the character-defining features of a National Register of Historic Places eligible or listed structure, site, district, or cultural landscape. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Moderate: The action would change a character-defining feature(s) of the eligible or listed properties, sites, district, or cultural landscape, but would not diminish the integrity of the resource to the extent that its National Register eligibility would be jeopardized. For purposes of Section 106, the determination of effect would be *adverse effect*.

Major: The action would change a character-defining feature(s) of a National Register eligible or listed structure, site, district, or cultural landscape, diminishing the integrity to the extent that it is no longer eligible to be listed in the National Register. For purposes of Section 106, the determination of effect would be *adverse effect*.

Beneficial effects would preserve and protect the integrity of cultural resources.

Adverse effects would damage or diminish the integrity of cultural resources.

Long-term: Any effects on cultural resources would be long-term because these resources are non-renewable.

IMPACTS OF ALTERNATIVE A – NO ACTION / CONTINUE CURRENT MANAGEMENT

Analysis

Archeological Resources. Under alternative A, current management would continue in the area impacted by the 2003 Grand Ditch breach. An assessment conducted by a park archeologist following the 2003 breach concluded that no known archeological resources were impacted as a result of breach-related damage to the landscape within the Kawuneeche Valley (NPS 2003a). There would be no excavations or ground-disturbing activities anticipated under alternative A with the potential to damage known archeological resources in the project area. Known archeological resources, specifically the Lulu City site and the surviving remnants of its associated wagon roads, would remain undisturbed in their current state. As such, alternative A would result in long-term, negligible impacts on archeological resources within the project area.

Historic Structures. Under alternative A, current management would continue in the area impacted by the 2003 Grand Ditch breach. While the events of 2003 likely impacted the National Register of Historic Places eligibility of the particular segment of the Grand Ditch found within the project area (including the breach of the ditch itself, road repair, and installation of a new box culvert in ditch), there would be no construction activities under alternative A with the potential to affect the historic fabric or character-defining features of the Grand Ditch. As such, alternative A would result in long-term, negligible impacts on the one historic structure identified within the project area.

Cumulative Impacts

Archeological Resources. Over time, archeological resources within the project area are subject to a variety of disturbances associated with natural erosion processes, inclement weather that can overturn trees and dislodge buried sites, inadvertent visitor use impacts, and artifact looting. These ongoing factors can contribute to diminish the integrity of archeological resources as the potential of impacted sites to yield important prehistoric or historic information is lessened and/or irretrievably lost. Otherwise, no specific policies, plans, or actions were identified that have the potential to impact archeological resources within the project area. Therefore, cumulative impacts on archeological resources are long-term, minor, and adverse.

When the long-term, negligible impacts of implementing alternative A are added to the long-term, minor, and adverse effects of other past, present, and reasonably foreseeable actions as described above, there would be overall long-term, minor, adverse cumulative impacts on the archeological resources within the project area. The contribution of alternative A to the cumulative impacts would be small.

Historic Structures. No past, present, or reasonably foreseeable future actions were identified which would have an effect on historic structures within the project area. Therefore, there would be no cumulative impacts on historic structures under alternative A.

Conclusion

Archeological Resources. Alternative A contains no ground disturbing activities; therefore, there is no potential to encounter archeological resources under this alternative. Alternative A would have a long-term, negligible impact on archeological resources. Therefore, it would not measurably add to or detract from the existing long-term, minor, adverse cumulative impacts, resulting in overall long-term, minor, adverse cumulative impacts.

Historic Structures. Alternative A includes no specific actions that would lead to changes to the park's historic structures, resulting in a long-term, negligible impact on the historic structure found within the project area. There would be no cumulative impacts on historic structures under this alternative.

Section 106 Summary

Archeological Resources. After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR Part 800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of alternative A would have *no adverse effect* on the Lulu City District or the Wagon Road within the project area at Rocky Mountain National Park.

Historic Structures. After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR Part 800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of alternative A would have *no adverse effect* on the Grand Ditch within the project area at Rocky Mountain National Park.

IMPACTS OF ALTERNATIVE B – MINIMAL RESTORATION

Analysis

Archeological Resources. Under alternative B, management activities within the project area would be conducted on a small scale using hand tools. Although this alternative includes some ground-disturbing activities within the project area, excavation would be minimal. Furthermore, ground disturbance would not occur in areas that contain known archeological resources. The Upper Kawuneeche Valley was surveyed for archeological resources within the last ten years (Brunswig 2002); therefore, the likelihood of encountering previously undisturbed or unsurveyed archeological resources is relatively low. If during restoration implementation fieldwork, previously unknown archeological resources were uncovered, all work in the immediate vicinity of the discovery would be halted until the resources could be identified and documented. The National Park Service would initiate consultation with the Colorado State Historic Preservation Office and affiliated tribal historic preservation offices, and an appropriate mitigation strategy would be developed. Impacts after mitigation would be confined to a small area with little, if any, loss of important information potential. As such, any potential impacts on archeological resources resulting from restoration activities proposed under alternative B would be long-term, negligible to minor, and adverse.

Historic Structures. Alternative B would include activities along the road adjacent to the Grand Ditch in support of restoration activities at lower elevations. More specifically, the road would be used to stabilize zone 1A under option 1 or 2. Under option 2, the Grand Ditch Road would be used to haul fill material with heavy trucks, as well as for dumping fill material into the breached area of zone 1A. Use of heavy machinery would therefore increase along this portion of the ditch road due to the proposed stabilization activities, resulting in increased wear and tear. Because damage associated with the 2003 breach likely resulted in a substantial impact on the National Register of Historic Places eligibility of this segment of the resource, the activities associated with stabilization of zone 1A would not be expected to contribute to the preexisting loss of historic fabric or character-defining features of the Grand Ditch within the project area. Stabilization of zone 1A would have long-term, minor, adverse impacts on this historic resource.

However, stabilization that would result from implementing option 1 or 2 in zone 1A could serve to increase overall stability of the Grand Ditch in this area, thus reducing the possibility of future breaches and enhancing the protection of this historic resource. This would result in long-term, moderate, beneficial impacts due to the preservation of its linear entirety. Overall, alternative B would result in long-term, beneficial impacts on the Grand Ditch due to the preservation of its linear entirety.

Cumulative Impacts

Archeological Resources. The preexisting cumulative impacts on archeological resources would be the same as described in alternative A. When the long-term, negligible to minor, adverse impacts of implementing alternative B are added to the long-term, minor, adverse effects of other past, present, and reasonably foreseeable actions previously discussed, there would be overall long-term, minor, adverse cumulative impacts on the archeological resources within the project area. The contribution of alternative B to the cumulative impacts would be small.

Historic Structures. No past, present, or reasonably foreseeable future actions were identified which would have an effect on historic structures within the project area. Therefore, there would be no cumulative impacts on historic structures under alternative B.

Conclusion

Archeological Resources. Alternative B includes restoration activities that are unlikely to disturb archeological resources. Mitigation actions would ensure that any impacts resulting from disturbance from restoration activities under this alternative would be long term, negligible to minor, and adverse. Therefore, it would incrementally add to the existing long-term, minor, adverse cumulative impacts, resulting in overall long-term, minor, adverse cumulative impacts.

Historic Structures. Alternative B includes elements that would lead to long-term, minor, adverse impacts as well as long-term, moderate, beneficial impacts, combining to result in long-term, moderate, beneficial impacts on the historic structure found within the project area due to the preservation of its linear entirety. There would be no cumulative impacts on historic structures under this alternative.

Section 106 Summary

Archeological Resources. After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR Part 800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of alternative B would have *no adverse effect* on the Lulu City District or the Wagon Road within the project area at Rocky Mountain National Park.

Historic Structures. After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR Part 800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of alternative B would have *no adverse effect* on the Grand Ditch within the project area at Rocky Mountain National Park.

IMPACTS OF ALTERNATIVE C – HIGH RESTORATION

Analysis

Archeological Resources. Alternative C includes more intensive management actions than described in alternative B, which would involve a greater degree of ground disturbance. In the upland areas of zones 1B, 2, and along the banks of the river outside of the active channel in zone 3, large mechanized equipment would be used to stabilize or recontour some areas, and to remove debris and soil in other locations. Also under alternative C, the berm along the east bank of the Colorado River (area L on figure 2.17) would be breached to enhance wetland storage capacity within the floodplain area. The elevation to the south of this area is higher and would therefore prevent the potential for flooding to extend to the Lulu City site or associated wagon roads. Otherwise, impacts under this alternative would be the same as described for alternative B. Known archeological sites would be avoided; the likelihood of encountering previously unknown archeological resources would be low; and work-stoppage, identification, documentation, consultation, and mitigation would take place in the unlikely event of encountering a resource. As such, any potential impacts on archeological resources resulting from restoration activities proposed under alternative C would be long-term, negligible to minor, and adverse.

Historic Structures. Under alternative C, impacts on the Grand Ditch would be the same as described under alternative B. Although the use of heavy machinery along the ditch road could result in minor adverse impacts on a segment of the resource that has previously been compromised by the 2003 breach, stabilization resulting from the alternative would substantially counteract that adverse impact to result in long-term, moderate, beneficial impacts associated with the preservation of the National Register of Historic Places listed resource as a whole.

Cumulative Impacts

Archeological Resources. The preexisting cumulative impacts on archeological resources would be the same as described in alternative A. When the long-term, negligible to minor, adverse impacts of implementing alternative C are added to the long-term, minor, adverse effects of other past, present, and reasonably foreseeable actions previously discussed, there would be overall long-term, minor, adverse cumulative impacts on the archeological resources within the project area. The contribution of alternative C to the cumulative impacts would be small.

Historic Structures. No past, present, or reasonably foreseeable future actions were identified which would have an effect on historic structures within the project area. Therefore, there would be no cumulative impacts on historic structures under alternative C.

Conclusion

Archeological Resources. Alternative C includes restoration activities that are unlikely to disturb archeological resources. Mitigation actions would ensure that any impacts resulting from disturbance by restoration activities under this alternative would be long term, negligible to minor, and adverse. Therefore, it would incrementally add to the existing long-term, minor, adverse cumulative impacts, resulting in overall long-term, minor, adverse cumulative impacts.

Historic Structures. Alternative C includes elements that would lead to both long-term, minor, adverse impacts, as well as long-term, beneficial impacts, combining to result in long-term, moderate, beneficial impacts on the historic structure found within the project area due to the stabilization provided to the Grand Ditch. There would be no cumulative impacts on historic structures under this alternative.

Section 106 Summary

Archeological Resources. After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR Part 800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of alternative C would have *no adverse effect* on the Lulu City District or the Wagon Road within the project area at Rocky Mountain National Park.

Historic Structures. After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR Part 800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of alternative C would have *no adverse effect* on the Grand Ditch within the project area at Rocky Mountain National Park.

IMPACTS OF ALTERNATIVE D – THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Analysis

Archeological Resources. Under alternative D, ground disturbance and subsequent impacts would be the same as described in alternative C. Known archeological sites would be avoided; likelihood of encountering previously unknown archeological resources would be low; and work-stoppage, identification, documentation, consultation, and mitigation would take place in the unlikely event of encountering a resource. As such, any potential impacts on archeological resources resulting from restoration activities proposed under alternative D would be long-term, negligible to minor, and adverse.

Historic Structures. Under alternative D, impacts on the Grand Ditch would be the same as described under alternative B. Although the use of heavy machinery along the ditch road could result in minor adverse impacts on a segment of the resource that has previously been compromised by the 2003 breach, stabilization resulting from the alternative would substantially counteract that adverse impact to result in long-term, moderate, beneficial impacts associated with the preservation of the National Register of Historic Places listed resource as a whole.

Cumulative Impacts

Archeological Resources. The preexisting cumulative impacts on archeological resources would be the same as described in alternative A. When the long-term, negligible to minor, adverse impacts of implementing alternative D are added to the long-term, minor, adverse effects of other past, present, and reasonably foreseeable actions previously discussed, there would be overall long-term, minor, adverse cumulative impacts on the archeological resources within the project area. The contribution of alternative D to the cumulative impacts would be small.

Historic Structures. No past, present, or reasonably foreseeable future actions were identified which would have an effect on historic structures within the project area. Therefore, there would be no cumulative impacts on historic structures under alternative D.

Conclusion

Archeological Resources. Alternative D includes restoration activities that are unlikely to disturb archeological resources. Mitigation actions would ensure that any impacts resulting from disturbance by restoration activities under this alternative would be long term, negligible to minor, and adverse. Therefore, it would incrementally add to the existing long-term, minor, adverse cumulative impacts, resulting in overall long-term, minor, adverse cumulative impacts.

Historic Structures. Alternative D includes elements that would lead to long-term, minor, adverse impacts as well as long-term beneficial impacts, combining to result in long-term, moderate, beneficial impacts on the historic structure within the project area due to the stabilization provided to the Grand Ditch. There would be no cumulative impacts on historic structures under this alternative.

Section 106 Summary

Archeological Resources. After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR Part 800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of alternative D would have *no adverse effect* on the Lulu City District or the Wagon Road within the project area at Rocky Mountain National Park.

Historic Structures. After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR Part 800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of alternative D would have *no adverse effect* on the Grand Ditch within the project area at Rocky Mountain National Park.

IMPACTS OF ALTERNATIVE E – MAXIMUM RESTORATION

Analysis

Archeological Resources. Under alternative D, ground disturbance and subsequent impacts would be the same as described in alternative C, with the exception of one additional aspect. A former wagon road which now exists as the Colorado River/Lulu City Trail would be crossed by a staging/haul road for heavy equipment. Remnants of the former wagon road may potentially fall within the staging/haul road where it overlaps the trail. Should this overlap exist, protective measures such as temporary bridging or metal tracking would be installed in order to avoid impacts on any visible remnants of the historic wagon trail. In light of these mitigation measures, impacts on the wagon road would be long-term, minor, and adverse. Overall impacts resulting from implementation of alternative E would be long-term, negligible to minor, and adverse.

Historic Structures. Under alternative E, impacts on the Grand Ditch would be the same as described under alternative B. Although the use of heavy machinery along the ditch road could result in minor adverse impacts on a segment of the resource that has previously been compromised by the 2003 breach, stabilization resulting from the alternative would substantially counteract that adverse impact to result in long-term, moderate, beneficial impacts associated with the preservation of the National Register of Historic Places listed resource as a whole.

Cumulative Impacts

Archeological Resources. The preexisting cumulative impacts on archeological resources would be the same as described in alternative A. When the long-term, negligible to minor, adverse impacts of implementing alternative E are added to the long-term, minor, adverse effects of other past, present, and reasonably foreseeable actions previously discussed, there would be overall long-term, minor, adverse cumulative impacts on the archeological resources within the project area. The contribution of alternative E to the cumulative impacts would be small.

Historic Structures. No past, present, or reasonably foreseeable future actions were identified which would have an effect on historic structures within the project area. Therefore, there would be no cumulative impacts on historic structures under alternative E.

Conclusion

Archeological Resources. Alternative E includes restoration activities that are unlikely to disturb archeological resources. Mitigation actions would ensure that any impacts resulting from disturbance by restoration activities under this alternative would be long term, negligible to minor, and adverse. Therefore, it would incrementally add to the existing long-term, minor, adverse cumulative impacts, resulting in overall long-term, minor, adverse cumulative impacts.

Historic Structures. Alternative E includes elements that would lead to both long-term, minor, adverse impacts, as well as long-term beneficial impacts, combining to result in long-term, moderate, beneficial impacts on the historic structure found within the project area due to the stabilization provided to the Grand Ditch. There would be no cumulative impacts on historic structures under this alternative.

Section 106 Summary

Archeological Resources. After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR Part 800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of alternative E would have *no adverse effect* on the Lulu City District or the Wagon Road within the project area at Rocky Mountain National Park.

Historic Structures. After applying the Advisory Council on Historic Preservation's criteria of adverse effects (36 CFR Part 800.5, *Assessment of Adverse Effects*), the National Park Service concludes that implementation of alternative E would have *no adverse effect* on the Grand Ditch within the project area at Rocky Mountain National Park.

VISITOR USE AND EXPERIENCE

REGULATIONS, GUIDANCE, AND POLICIES

National Park Service Management Policies

Management Policies (NPS 2006a) section 8.2 states that the enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all park units and that the National Park Service is committed to providing appropriate, high-quality opportunities for visitors to enjoy the national parks. Because many forms of recreation can take place outside of a national park setting, the National Park Service therefore seeks to:

- Provide opportunities for forms of enjoyment that are uniquely suited and appropriate to the superlative natural and cultural resources found in a particular park unit.
- Defer to others to meet the broader spectrum of recreational needs and demands that do not depend on a national park setting. Those others can include local, state, and other federal agencies; private industry; and nongovernmental organizations.

Part of the purpose of the national parks is to provide for public outdoor recreation use and enjoyment. Goals for visitor experience provided in the NPS *Strategic Plan* for 2000 through 2005 (NPS 2005b) include:

- NPS Mission Goal IIa: Visitors safely enjoy and are satisfied with availability, accessibility, diversity, and quality of park facilities, services, and appropriate recreational opportunities.
- NPS Mission Goal IIb: Park visitors and the general public understand and appreciate the preservation of parks and their resources for this and future generations.

Implementation of this policy must meet the Organic Act's requirement that the park service conserve the scenery, natural and historic objects, and wildlife to leave them unimpaired for the enjoyment of future generations.

Management Policies also specifies that visitor activities appropriate to the park environment will be encouraged, whereas those that would impair park resources or are contrary to the purposes for which the park was established will not be permitted.

Section 8.4 of NPS *Management Policies* mandates that all necessary steps be taken to avoid or mitigate adverse effects from aircraft overflights to reduce adverse effects on resources and visitor enjoyment.

Any closures or restrictions, other than those imposed by law, must be consistent with applicable laws, regulations, and policies, and (except in emergency situations) require a written determination by the superintendent that such measures are needed for any of the following reasons:

- Protect public health and safety,
- Prevent unacceptable impacts on park resources or values,
- Carry out scientific research,
- Minimize visitor use conflicts, or
- Otherwise implement management responsibilities.

METHODS AND ASSUMPTIONS FOR ANALYZING IMPACTS

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts includes the restoration area and nearby areas in the Kawuneeche Valley of Rocky Mountain National Park.

Issues

Issues identified during internal and public scoping that relate to how restoration alternative approaches may affect visitor use and experience include:

- The natural and unaltered landscape of the park is an important component of visitors' experience. Structures and physical intrusions, such as fences, can detract from the viewshed and adversely affect the quality of the park experience.
- Noise associated with restoration activities can intrude on visitors' experience and disrupt feelings of quiet and solitude.
- Many members of the public are unaware of some of the hydrologic and ecological damages caused by the 2003 breach and may not understand the need for restoration activities in some areas.
- Some restoration activities would require temporary closure of trails and backcountry campsite areas to visitors' use, which can detract from the park experience.

Assumptions

The following general assumptions were used to analyze the effects of restoration actions on visitor use and experience:

- Work would progress in multiple locations simultaneously.
- Work would be conducted during daylight hours.
- Work would be limited to those months of the year where weather allows for access to the project area, generally during the late spring and summer months.
- Portions of the Grand Ditch, Colorado River, and Thunder Pass Trails and the dispersed backcountry campsites within the vicinity of the project area would be temporarily closed during restoration activities to ensure the safety of visitors.
- Visitors would still be provided access to the Kawuneeche Valley and the Grand Ditch Trail from Red Mountain Pass Trail to the south, or during some stages of restoration from the eastern fork of the Colorado River Trail to the Little Yellowstone Trail.

Assessment Methods

This impact analysis examines whether restoration of the 2003 Grand Ditch breach would be compatible with desired visitor experience goals and the purpose of the park as identified in the enabling legislation and in other laws and policies affecting visitor use.

To determine the effects of the alternatives on visitor experience, each issue was evaluated using the procedures described in the "General Methodologies" section near the beginning of this chapter. This impact analysis evaluates several aspects of visitor experience, including access to park resources and wilderness in the Kawuneeche Valley, perception of the natural soundscape, and understanding and appreciating park values.

The other plans and projects whose effects could cumulatively combine with the effects of the Grand Ditch breach restoration alternatives were presented in chapter 1. Only plans and projects that would have effects on visitor use and experience within the Kawuneeche Valley are considered in the assessment of cumulative effects on visitor use and experience. The cumulative effects analyses for each of the alternatives evaluates the effects of the other plans and projects on a particular resource, adds the effects identified by the specific restoration alternative, and then identifies the total cumulative effect, including the degree that the restoration alternative contributes to the overall cumulative effect.

Impact Threshold Definitions

Negligible: Visitors would not be affected or changes in visitor experience or understanding would be below or at the level of detection. Visitors would not likely be aware of the effects associated with the alternative.

Minor: Changes in visitor experience or understanding would be detectable, although the changes would be slight. Visitors could be aware of effects associated with the alternative, but only slightly.

Moderate: Changes in visitor experience or understanding would be readily apparent. Visitors would be aware of the effects associated with the alternative and would likely be able to express an opinion about the changes.

Major: Changes in visitor experience or understanding would be severe or exceptional, readily apparent, and would have important consequences. Visitors would be aware of the effects associated with the alternative and would likely express strong opinion about the changes.

Beneficial impacts would improve visitor enjoyment and recreational or educational opportunities.

Adverse impacts would diminish visitor enjoyment and recreational or educational opportunities.

Short-term: Effects would cease within three years following implementation of the action.

Long-term: Effects would extend more than three years beyond implementation of a restoration action.

IMPACTS OF ALTERNATIVE A – NO ACTION / CONTINUE CURRENT MANAGEMENT

Analysis

Natural Park Experience. Under the no action alternative, no management actions would occur within the project area and therefore the visitor use and experience would not change from current conditions.

Intrusions to the natural park experience for visitors in the Kawuneeche Valley may come from impacts on the natural soundscape from other visitors or aircraft (see the natural soundscapes section in chapter 3 for additional information on intrusions to the natural soundscape). Under the no action alternative, motorized equipment and mechanical transport would continue to be prohibited in the wilderness area of the Kawuneeche Valley, except during emergency operations or when “absolutely critical” for the protection of natural or cultural resources. Noise generated by other visitors would fluctuate with the seasons, day of the week, and time of day. Impacts on visitor use and experience from intrusions to the natural soundscape would be negligible to minor and adverse depending on the time of year and location.

Under the no action alternative, visual evidence of damages from the Grand Ditch breach would remain evident; particularly areas of erosion and debris deposition such as the alluvial fan in zone 2. Full recovery of forested habitat would take 200 to 350 years. The continued visual evidence of damages would have long-term adverse impacts of minor to moderate intensity on visitor use and experience.

Access. Under the no action alternative, access in the wilderness areas of the Kawuneeche Valley would continue to be limited to foot and horse use. The Colorado River Trail network and the numerous backcountry campsites within the Kawuneeche Valley would remain open and accessible from several locations both within and outside of the park boundaries. Impacts on visitor use and experience from the continued access provided by the numerous trails and campsites within the Kawuneeche Valley would result in long-term beneficial impacts.

Cumulative Impacts

Rocky Mountain National Park is one of the most popular parks in the national park system. Since 2001, visitation to Rocky Mountain National Park has averaged 2,895,028, with a peak of 3,139, 685 visitors in 2001. Of these visitors, only about 15% enter the park on the west side close to the Kawuneeche Valley and approximately 500,000 visitors make the trip from Estes Park to the Grand Lake area when Trail Ridge Parkway is open, generally late May to early October (NPS 2004c, Town of Grand Lake 2005).

Visitors are positively affected by a wide range of opportunities and facilities within the Kawuneeche Valley. Visitors engage in popular activities including viewing wildlife and scenery, hiking, backpacking, and horseback riding; fly fishing, bird watching, and photography. Backcountry visitors have access to multiple trails and 10 backcountry camp sites available within the surrounding area of the Kawuneeche Valley.

Conditions also exist in the park that result in adverse impacts on visitor experience. High levels of visitation to national parks results in crowding, dissatisfaction (Gramann 2002). Other activities have the potential for adversely affecting visitor experience, including overflights by commercial aircraft from Denver International Airport, park search and rescue, and the use of machinery and equipment for resource management. These conditions can have short-term, minor to moderate, adverse impacts on visitor experience.

Since 1990, bark beetles have killed thousands of acres of lodgepole pine trees in Rocky Mountain National Park, including trees in the vicinity of the Grand Ditch breach. Although bark beetle infestations occur naturally in forested ecosystems, current outbreaks across western North America are the largest and most severe in recorded history (Bentz 2008). In the Rocky Mountain region, pine beetles have killed large expanses of forests and dramatically altered the landscape. Impacts on visitor use and experience have resulted from the visual evidence and temporary closure of selected frontcountry and backcountry locations due to mitigation for human safety. Management of the bark beetle within Rocky Mountain National Park is in accordance with the *Bark Beetle Management Plan* (NPS 2005a). The continued pine beetle outbreak contributes both short- and long-term adverse impacts of moderate to major intensity to visitor use and experience.

The park manages the impacts of these conditions through the development of management plans and implementation of subsequent actions to improve the experience of visitors. Past and future management plans that affect visitor use and experience within the vicinity of the Kawuneeche Valley include the snowmobile management plan (NPS 2002a), the commercial horse use plan (NPS

1994), and the backcountry and wilderness management plan including the use of minimum tool analysis (NPS 2001a). These plans and actions have altered or will alter conditions, with short-term, adverse effects on visitor experience. However, these plans have long-term beneficial effects on visitor experience.

The overall satisfaction of visitors was measured for both summer and winter visitors with the Rocky Mountain National Park visitor study for summer 2010 and winter 2011 (NPS 2010c, NPS 2004a). Ninety-five percent of park visitors are satisfied overall with appropriate facilities, services, and recreational opportunities. The benefits of opportunities and facilities at Rocky Mountain National Park are readily apparent to visitors, and their positive opinions, combined with past and future actions of the park to manage park conditions, indicate a long-term beneficial, cumulative impact on visitor experience.

Within the project area, research studies evaluating hydrologic conditions and flows have been ongoing since the 2003 breach. Scientific monitoring equipment is temporary and may or may not be visible to visitors. Effects on visitor use and experience from the presence of scientific monitoring equipment contributes negligible to minor and adverse impacts.

Collectively, the effects on visitor use and experience within the Kawuneeche Valley caused by past, current, and foreseeable future actions would be long-term, minor, and adverse.

Impacts on visitor use and experience from alternative A would be long term, negligible to moderate adverse and long term, moderate, beneficial.

Cumulatively, alternative A would combine with past, present, and foreseeable future actions to result in continued long-term, minor, adverse, cumulative impacts. Alternative A would have a modest contribution to these cumulative impacts.

Conclusion

Under the no action alternative, no management actions would occur. Impacts on visitor use and experience from intrusions to the natural soundscape would be negligible to minor and adverse depending on the time on the time of year and location. Impacts on visitor use and experience from the continued visual evidence of damages from the breach would be long-term, minor to moderate, and adverse. Access provided by the numerous trails and campsites within the Kawuneeche Valley would continue to result in long-term, moderate, beneficial impacts.

Cumulative impacts on visitor use and experience would continue to be long-term, minor, and adverse. This alternative's contribution to these effects would be modest.

IMPACTS OF ALTERNATIVE B – MINIMAL RESTORATION

Analysis

Natural Park Experience. In zone 1A, installation of (option 1 or option 2 would require the use of heavy machinery and a helicopter for transport of machinery at the start and end of restoration activities. Implementation of alternative B would start in the late spring and extend until early fall over the course of two years. This time of year coincides with the highest visitor use of the project area. During implementation, the equipment would be visible and audible from various trails in the northern portion of the Kawuneeche Valley. The noise and visual presence of machinery during implementation of either stabilization option would have a short-term, moderate, and adverse impact on visitor use and experience. Under option 1, the stabilized slope would not be revegetated but would eventually revegetate once soils became stabilized. Under option 2, the backfilled and stabilized slope would be revegetated with native species that exist on slopes adjacent to zone 1A. Either option would eventually look similar to the adjacent sparsely vegetated slopes, resulting in negligible, beneficial impacts on visitor use and experience.

Restoration activities in zones 1B through 4 would be implemented using hand tools and would therefore not produce as much noise as the machinery in zone 1A. Impacts on visitor use and experience would occur from the visual presence of work crews, line camps, and the intrusions of human voices and hand tools to the natural soundscape. These intrusions would contribute short-term, negligible to minor, and adverse impacts on visitor use and experience depending on distance from and visibility of work crews and camps.

For more information on intrusions of noise in the project area soundscape, see the natural soundscapes section.

While most of the debris from the 2003 breach would remain in place under alternative B, over the long term, revegetation and stabilization along the banks would improve the aesthetic experience of backcountry visitors in areas where hiking trails are immediately adjacent to or across from Lulu Creek or the Colorado River. The reduced visual impacts would result in negligible, beneficial impacts on visitor use and experience.

Access. Under alternative B, installation option 1 or 2 in zone 1A would result in temporary closures of the Grand Ditch Trail. While areas on either side of the closure may be accessible by alternative routes, accessing them would add considerable mileage. Due to the terrain and remote location of this portion of trail, closure of a section of the Grand Ditch Trail would result in short-term, adverse impacts of moderate intensity to visitor use and experience.

During implementation of restoration in zones 1B through 4, portions of the Colorado River and Thunder Pass Trails could be temporarily closed. Alternative routes would still allow for access to portions of the Kawuneeche Valley. Due to the proximity of alternative routes and the availability of alternative campsites, closure of the trails and campsites would result in localized, short-term adverse impacts of negligible to minor intensity to visitor use and experience.

Cumulative Impacts

Past, current, and foreseeable future actions that impact visitor use and experience within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on visitor use and experience would continue to be long-term, minor, and adverse. The actions associated with alternative B would have a modest adverse contribution to the cumulative impacts on visitor use and experience.

Conclusion

Under alternative B, short-term impacts on visitor use and experience from the visual presence of equipment and crews and intrusions to the natural soundscape from stabilization of zone 1A by option 1 or 2 would be moderate and adverse. Long-term impacts would be negligible and beneficial.

Short-term impacts on visitor use and experience from restoration in zones 1B through 4 would be negligible to minor and adverse during implementation. Long-term impacts from revegetation and the improved aesthetic experience would be negligible and beneficial.

Temporary closures to backcountry campsites and portions of the Grand Ditch, Colorado River, and Thunder Pass Trails within close proximity to the project area would have short-term adverse impacts of negligible to moderate intensity depending on the trail and location.

Cumulative impacts on visitor use and experience would continue to be long-term, minor, and adverse. This alternative's contribution to these effects would be modest and adverse.

IMPACTS OF ALTERNATIVE C – HIGH RESTORATION

Analysis

Natural Park Experience. As under alternative B, restoration activities would take place during working hours for approximately three to five months each year for two years. Under alternative C, impacts from implementation of option 1 or 2 in zone 1A would be the same as those described under alternative B. However, under alternative C restoration activities in zones 1B through 4 would also utilize heavy machinery and the occasional use of helicopters to implement mobilization and restoration activities such as revegetation, stabilization, and debris removal. The use of helicopters would occur predominantly at the start and end of restoration activities. The combined use of heavy machinery in all zones would increase noise levels across the project area. In addition, browsing exclosure fences would be installed around willow plantings in zones 3 and 4. Installation and removal of these temporary browsing exclosure fences in 15 to 20 years, once the willow were established, would require the use of mechanized equipment over the course of several days. Noise intrusions resulting from restoration implementation fieldwork would be short term, minor to major, and adverse depending on the visitor's distance from the project area.

Under alternative C, terraces would be implemented from the debris removed in zones 2 and 4. These terraces would be located in areas that were previously undisturbed and would create a visual intrusion to visitors until revegetation efforts became established. Additionally, temporary browsing exclosure fences around willow plantings in zones 3 and 4 would add an additional visual intrusion that would impact visitor use and experience. A visitor survey conducted to determine park visitor's preferences for elk management within the park found visitors to be fairly evenly divided in their opinions on the acceptability of such exclosure fences for vegetation management (Cordova 2000). Fencing would detract from the natural appearance, important to many visitors, diminishing the park's reputation. Mitigation measures could include exclosure fencing types that blend in with the surroundings and public education. Temporary browsing exclosure fences would be removed once the willows were established in 10-15 years. Impacts from the visual intrusions associated with restoration implementation fieldwork would result in short-term, moderate to major, adverse impacts on visitor use and experience.

Over the long term, restoration actions, including enhanced vegetation, establishment of tall willows, recontoured slopes, debris removal, and enhanced wetland conditions, would greatly reduce the visual evidence of the damage caused by the 2003. These changes would be detectable by visitors within the project area and would result in minor, beneficial impacts.

Access. Under alternative C, impacts on visitor use and experience from closure of a portion of the Grand Ditch Trail would be the same as described under alternative B. Short-term, impacts on visitor use and experience would be moderate and adverse.

Impacts on visitor use and experience from closures to backcountry campsites and portions of the Colorado River and Thunder Pass Trails would be similar to those described under alternative B. However, due to increased debris removal and the use of machinery these closures could occur for a longer duration. Closure of these trails would not restrict access to the Kawuneeche Valley and would result in localized, short-term, adverse impacts of minor to moderate intensity.

Cumulative Impacts

Past, current, and foreseeable future actions that impact visitor use and experience within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on visitor use and experience would continue to be long-term, minor, and adverse. The actions associated with alternative C would have a modest and adverse short-term contribution and a long-term modest beneficial contribution to the cumulative impacts on visitor use and experience.

Conclusion

Under alternative C, short-term impacts on visitor use and experience from the visual presence of equipment and crews and intrusions to the natural soundscape from stabilization of zone 1A by option 1 or 2 would be moderate and adverse. Long-term impacts would be moderate and beneficial.

Short-term impacts on visitor use and experience from intrusions to the natural soundscape from restoration fieldwork in zones 1B through 4 would be minor to major and adverse, depending on the visitor's distance from the project area.

The visual presence of equipment, crews, temporary browsing exclosure fences, and debris terraces would be short and long-term, moderate to major, and adverse. Long-term impacts from a reduction in the visual evidence of the 2003 breach would be minor and beneficial.

Temporary closures to the trails and backcountry campsites within and adjacent to the project area would have short-term adverse impacts of minor to moderate intensity depending on the trail and location.

Cumulative impacts on visitor use and experience would continue to be long-term, minor, and adverse. This alternative's contribution to these effects would be modest and adverse over the short term and modest and beneficial over the long term.

IMPACTS OF ALTERNATIVE D – THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Analysis

Natural Park Experience. As under alternative B and C, restoration activities would take place during working hours for approximately three to five months each year for two years. Under alternative D, impacts from implementation of option 1 in zone 1A and restoration activities in zones 1B through 4 would be the same as those described under alternative C and would be long term, moderate, and beneficial.

Under alternative D, additional debris would be removed from the alluvial fan and in zone 4 and therefore could require the use of machinery for a longer period. Impacts from the installation and removal of temporary browsing exclosure fences would be the same as described under alternative C although more extensive willow plantings under the NPS preferred alternative would require additional browsing exclosure fences and could take several days longer to install and remove. Noise intrusions from implementation of the NPS preferred alternative would be the similar to those described under alternative C and would vary depending on the visitor's distance from the project area. These impacts would be short-term, minor to major, and adverse.

Due to the increased amount of debris removal under this alternative, additional terraces would be implemented in areas that were previously undisturbed. Additionally, similar to alternative C, willows plantings would require extensive browsing exclosure fences. Mitigation measures would be the same as those described under alternative C. Visual impacts would remain concentrated in certain areas and impacts on visitors would therefore be similar to those described in alternative C; short and long-term impacts would be moderate to major and adverse.

Long-term impacts from restoration actions would be the same as those described under alternative C and would be minor and beneficial.

Access. Under alternative D, impacts on visitor use and experience from closure of a portion of the Grand Ditch Trail would be the same as described under alternative B. Short-term, impacts on visitor use and experience would be moderate and adverse.

Under alternative D, impacts on visitor experience from closure to backcountry campsites and portions of the Colorado River and Thunder Pass Trails would be the same as those described under alternative C. Closure of these trails would not restrict access to the Kawuneeche Valley and would result in localized, short-term adverse impacts of minor to moderate intensity.

Cumulative Impacts

Past, current, and foreseeable future actions that impact visitor use and experience within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on visitor use and experience would continue to be long-term, minor, and adverse. The actions associated with alternative D would have a modest and adverse short-term contribution and a long-term, modest, beneficial contribution to the cumulative impacts on visitor use and experience.

Conclusion

Under alternative D, short-term impacts on visitor use and experience from the visual presence of equipment and crews and intrusions to the natural soundscape from stabilization of zone 1A by option 1 would be moderate and adverse. Long-term impacts would be moderate and beneficial.

Short-term impacts on visitor use and experience from intrusions to the natural soundscape from restoration implementation fieldwork would be minor to major, and adverse depending on the visitor's distance from the project area.

The visual presence of equipment, crews, temporary browsing exclosure fences, and debris terraces would be short and long-term, moderate to major, and adverse. Long-term impacts from a reduction in the visual evidence of the 2003 breach would be moderate and beneficial.

Temporary closures to the trails and backcountry campsites within and adjacent to the project area would have short-term adverse impacts of minor to moderate intensity depending on the trail and location.

Cumulative impacts on visitor use and experience would continue to be long-term, minor, and adverse. This alternative's contribution to these effects would be modest and adverse over the short term and modest and beneficial over the long term.

IMPACTS OF ALTERNATIVE E – MAXIMUM RESTORATION

Analysis

Natural Park Experience. Under alternative E, restoration activities would take place during working hours for approximately three to five months each year for two to three years. Impacts from implementation of option 1 or 2 in zone 1A would be the same as those described under alternative B.

Under alternative E, restoration activities in zones 1B through 4 would utilize heavy machinery to implement mobilization and restoration activities such as revegetation, stabilization, and debris removal for up to three seasons. The combined use of heavy machinery in all zones would increase noise levels across the project area for an extended period. Impacts from the installation and removal of temporary browsing exclosure fences would be the same as described in alternative C although more extensive willow plantings under alternative E would require additional browsing exclosure fences and could take several days longer to install and remove. While restoration implementation fieldwork could occur for an additional season, impacts on visitors from these intrusions would be similar to those described under alternative C and D. Impacts on visitors from noise intrusions would vary depending on their distance from the project area and would be short-term, minor to major, and adverse.

Extensive debris removal in zones 2 and 4 under alternative E would require the implementation of additional debris terraces. Due to an increased amount of debris being removed from zone 4, additional terraces would need to be implemented in areas that were previously undisturbed, creating a visual intrusion to visitors until revegetation efforts became established. Additional willow plantings, especially in zone 4 would require more extensive installation of temporary browsing exclosure fences. Mitigation measures would be the same as those described under alternative C. While visual impacts would increase incrementally under alternative E, these intrusions would remain concentrated in certain areas and impacts on visitors would therefore be similar to those described in alternative C; short and long-term impacts would be moderate to major and adverse.

Over the long term, restoration actions, including enhanced vegetation, extensive plantings of tall willow, recontoured slopes, extensive debris removal, and enhanced wetland conditions, would eliminate most of the visual evidence of the damage caused by the 2003 breach. These changes would be detectable to visitors within the project area and would result in long-term, moderate, beneficial impacts on visitor use and experience.

Access. Under alternative E, impacts on visitor use and experience from closure of a portion of the Grand Ditch Trail would be the same as described under alternative B. Short-term, impacts on visitor use and experience would be moderate and adverse.

Under alternative E, impacts on visitor experience from closures of backcountry campsites and portions of the Colorado River and Thunder Pass Trails would be similar to those described under alternative B. However, due to extensive debris removal and an additional work season, these closures could occur for a longer duration. Closure of these trails would not restrict access to the Kawuneeche Valley and would result in localized, short-term adverse impacts of moderate intensity.

Cumulative Impacts

Past, current, and foreseeable future actions that impact visitor use and experience within the Kawuneeche Valley would be the same as those described for alternative A. Collectively, the effects of these actions on visitor use and experience would continue to be long-term, minor, and adverse.

The actions associated with alternative E would have a modest and adverse short-term contribution and a long-term beneficial contribution to the cumulative impacts on visitor use and experience.

Conclusion

Under alternative E, short-term impacts on visitor use and experience from the visual presence of equipment and crews and intrusions to the natural soundscape from stabilization of zone 1A by option 1 or 2 would be moderate and adverse. Long-term impacts would be moderate and beneficial.

Short-term impacts on visitor use and experience from intrusions to the natural soundscape from restoration implementation fieldwork would be minor to major, and adverse depending on the visitor's distance from the project area.

The visual presence of equipment, crews, temporary browsing exclosure fences, and debris terraces would be short and long-term, moderate to major, and adverse. Long-term impacts from a reduction in the visual evidence of the 2003 breach would be moderate and beneficial.

Temporary closures to the trails and the backcountry campsites within and adjacent to the project area would have short-term adverse impacts of moderate intensity.

Cumulative impacts on visitor use and experience would continue to be long-term, minor, and adverse. This alternative's contribution to these effects would be modest and adverse over the short term and modest and beneficial over the long term.

PARK OPERATIONS

REGULATIONS, GUIDANCE, AND POLICIES

National Park Service Management Policies

Management Policies (NPS 2006a) gives guidance for the management of natural resources in the parks and how National Park Service staff should accomplish resource management goals through the use of various tools and approaches.

Park facilities and operations demonstrate the National Park Service's environmental leadership by incorporating sustainable practices to the maximum extent practicable in planning, design, siting, construction, and maintenance, including preventive and rehabilitative maintenance programs.

In regard to the park interpretive staff, Section 7.5.3 of *Management Policies* requires that "parks should, in balanced and appropriate ways, thoroughly integrate resource issues…into their interpretive and educational programs. Resource issue interpretation should be integrated into both on- and off- site programs, as well as into printed and electronic media whenever appropriate" (NPS 2006a). Augmenting the park's interpretive and educational programs to include information about resource management actions can build understanding of, and support for, the National Park Service's resource management decisions and the NPS mission in general. The park interpretive staff must be educated about the reasoning used in the decision-making process and be able to present a balanced view of the rationale.

METHODS AND ASSUMPTIONS FOR ANALYZING IMPACTS

Geographic Area Evaluated for Impacts

The geographic area of effect being evaluated for impacts on park operations is the northern portion of the Kawuneeche Valley adjacent to and including the area impacted by the 2003 Grand Ditch breach. Staff involved in the restoration and management of the area often have parkwide responsibilities that may be affected restoration activities. For this reason, the area of analysis is parkwide.

Issues

The following issues identified during internal and public scoping relate to how restoration alternative approaches may affect park operations:

- Additional staff may have to be hired to fill work crews.
- Contracts may have to be executed and administrated for restoration construction activities, and contractors will have to be managed.
- Educational and informational materials about the purpose and nature of the restoration construction activities and associated backcountry travel restrictions would need to be produced and distributed.
- Monitoring of the performance of restoration actions would need to be designed, implemented, and staffed.

Assumptions

Closing and/or rerouting trails and/or park areas during restoration activities would require additional staff. As conditions change in unanticipated ways in the implementation of the action alternatives, operations staffing needs would change accordingly. Under Alternative A, no additional staff would be added.

Good public education would be needed to inform and educate the public to help reduce negative public perceptions based on misinformation of the management action that is selected.

Implementation of any of the action alternatives would require additional park staff and/or contractors to accomplish the work.

Browsing exclosure fences installed in riparian willow areas would remain in place until willow were large enough to withstand browsing, which is expected to be five to 15 years.

Some fence material would be transported to locations where fences would be constructed using helicopter support, following minimum tool analysis for sites in wilderness.

Assessment Methods

Potential impacts on park operations, including staffing and funding needs, are assessed in relationship to the degree to restoration would change compared to existing management of these resources. Impacts on park operations were evaluated using the process described in the "General Methodology for Establishing Impacts Thresholds and Measuring Effects by Resource" section of this chapter. Information regarding park operations and staffing projections, as well as records used in this analysis, were obtained from the staff at Rocky Mountain National Park. The primary activities for which impacts were anticipated include restoration management and activities and education/interpretation. The steps for assessing impacts included 1) identifying existing responsibilities and routine tasks of the park staff divisions that may be affected by restoration actions, 2) determining the potential changes in staff duties or the need for additional staff and funding that would be caused by actions under each alternative, and 3) identifying the impacts of potential constraints in staffing.

The other plans and projects whose effects could cumulatively combine with the effects of the Grand Ditch breach restoration alternatives were presented in chapter 1. Only plans and projects that would have effects park operations within the Kawuneeche Valley are considered in the assessment of cumulative effects on park operations. The cumulative effects analyses for each of the alternatives evaluates the effects of the other plans and projects on a particular resource, adds the effects identified by the specific restoration alternative, and then identifies the total cumulative effect, including the degree that the restoration alternative contributes to the overall cumulative effect.

Impact Threshold Definitions

Negligible: Park operations would not be affected, or the effect would not be noticeable or measurable outside normal variability.

Minor: The effect on park operations would be measurable and might be noticed by park staff, but probably would not be noted by visitors.

Moderate: The effects on park operations would result in a substantial change in park operations and would be noticeable to park staff, but would probably not be noted by visitors.

Major: The effects on park operations would result in a substantial change in park operations and would be noticeable to both park staff and visitors. Staff and visitors would recognize the change as being quite different from existing operations.

Beneficial effects would reduce disruptions to park operations, or maintain (or potentially reduce) the duties related to management of the project area.

Adverse effects would create additional disruptions to park operations or would increase the duties associated with management of the project area.

Short-term: Impacts on park operations would not extend beyond restoration implementation fieldwork or would be intermittent and directly associated with the restoration activity being undertaken.

Long-term: Impacts on park operations would extend beyond restoration implementation fieldwork.

IMPACTS OF ALTERNATIVE A – NO ACTION / CONTINUE CURRENT MANAGEMENT

Analysis

Under the No Action Alternative, there would be no impact on park operations. No activity would be undertaken by park staff to alter or manage the conditions associated with the Grand Ditch breach. Research would continue in order to increase knowledge and understanding of the effects of the breach. This would include maintenance of groundwater test pits and data recording, and monitoring of hydrologic data. This activity would continue to be accomplished primarily by university researchers. Management of research agreements and activities by park staff would occur within the normal course of duties. There would continue to be little or no noticeable effect on park operations, and impacts would be negligible and long-term.

Cumulative Impacts

Park staff from all divisions would implement existing and future plans and actions throughout the park while operating the park and protecting its resources. Park staff would continue to implement any plan or project within the park. These plans and actions, if successful, would result in better-managed resources and improved effectiveness of park staff over the long term.

The Resource Stewardship Division staff organizes and conducts the monitoring and management actions such as exotic plant management, prescribed burns, and population and chronic wasting disease monitoring of wildlife. Fire management and fuels reduction activities throughout the park and dissemination of information to the public about the role of fire and the use of safe prescribed burning require a substantial commitment of staff and resources. Population monitoring of other wildlife and vegetation (such as elk and boreal toads) is conducted annually. The public would not likely notice any changes in park staff duties, but park staff would be aware of any fluctuations in duties related to these projects and actions. Therefore, the ongoing staff and resource commitment for these resource management efforts represents a long-term, minor, adverse effect on park operations.

The Facilities Management Division would continue to be responsible for regular and planned facility construction and maintenance. Trails would continue to be maintained and improved according to the trails management plan, and construction would occur for the future rerouting of the Continental Divide National Scenic Trail. Roads and the park's transportation system would continue to be maintained and repaired according to transportation management plan. These ongoing duties would represent long-term, minor, adverse effects on park operations.

Implementation of these past, present, and foreseeable future actions all represent increased duties for the park staff. These tasks combine to have long-term, minor to moderate, adverse, cumulative effects on park operations.

Alternative A would contribute long-term, negligible, adverse effects on park operations due to continued management of research activities associated with the Grand Ditch breach. Cumulatively, Alternative A with the other projects and actions would have long-term, minor to moderate, adverse effects on park operations. Alternative A's contribution to cumulative impacts would be small.

Conclusion

Under Alternative A, there would be little or no noticeable effect on park operations. On-going management of research activities associated with the effects of the Grand Ditch breach would result in long-term, negligible adverse impacts.

Cumulatively, Alternative A, with the other projects and actions, would have long-term, minor to moderate, adverse effects on park operations. Alternative A's contribution to cumulative impacts would be small.

IMPACTS OF ALTERNATIVE B – MINIMAL RESTORATION

Analysis

Under alternative B, most restoration construction activity would be performed using hand labor. This would include moving small amounts of debris, logs, and small boulders, and would be performed using methods that are regularly employed elsewhere in the park, such as by trail crews. Additional staff may be hired, as required. Park project managers would manage work crews; schedule work; and monitor and report work progress to park management. The effort required for these tasks would be within current capabilities of division staff, and would not be outside of normal variability of park operations. The impacts on park operations would be negligible, short-term, and adverse.

Restoration work in zone 1A would be conducted by contractors under supervision of an NPS manager. Contracts would be prepared, issued, and administered. Division and NPS contract staff are experienced and qualified to perform these duties and activities would not fall outside of normal park operations. However, an on-site NPS manager would be needed daily while restoration activities were underway. This may require additional staff and would have a measurable effect on park operations. The impacts on park operations would be minor, short-term, and adverse.

Following completion of restoration construction, the Resource Stewardship Division would monitor and evaluate restoration performance. Monitoring and evaluation activities would take place until vegetation has established and the site is reproducing vegetationally; this may take more than 10 years. This would require division staff to establish monitoring methods, execute scheduled trips to the project area to gather data, and prepare analysis and reports of findings. Under the no action alternative, division staff make regular trips into the project area to evaluate current conditions and to accomplish other tasks such as inventorying and monitoring of other park resources. The activity required to monitor and evaluate restoration performance would be accomplished within the regular activities of division staff or would not exceed the normal range of activity undertaken by division staff. Impacts on park operations would be negligible, short term, and adverse.

Cumulative Impacts

Cumulative effects of other plans and actions would be the same as described for alternative A: long term, minor to moderate, and adverse. Alternative B would have effects related managing the restoration project. Managing NPS work crews performing restoration activities, managing contracts and contractors in zone 1A, and conducting monitoring and evaluation activities, would result in short-term, negligible to minor, adverse impacts on park operations.

Overall, the cumulative effects of other plans and actions, combined with the effect from alternative B, would be long term, minor to moderate, and adverse. The contribution of alternative B to the cumulative impacts would be short term and modest.

Conclusion

Alternative B would result in long-term, negligible, adverse impacts from hiring and managing work crews and from monitoring and evaluating the performance of restoration actions, and in long-term, minor, adverse effects on park operations from managing contractors carrying out restoration actions.

Alternative B would make a modest, short-term, adverse contribution to overall long-term, minor to moderate, adverse, cumulative impacts on park operations.

IMPACTS OF ALTERNATIVE C – HIGH RESTORATION

Analysis

Restoration work throughout the project area may be managed through contracts, similar to that described for zone 1A in alternative B. Restoration activities may require multiple contracts or procurement actions by division staff and NPS contract professionals. Multiple managers would be needed to supervise restoration activities. Impacts on park operations would be minor to moderate, short-term, and adverse.

Following completion of restoration construction, the Resources Stewardship Division would monitor and evaluate restoration performance, as described in alternative B. Restoration activities would cover a more extensive area than in alternative B, and would include a wider variety of monitor tasks (e.g., groundwater monitoring, hydrologic monitoring, and vegetation monitoring inside and outside of exclosure fences). This would require a more intensive effort to execute and would produce more information to be analyzed and reported. Additional field and office time would be required that would be measurable but may not be a substantial change in operations. Impacts on park operations would be minor, short-term, and adverse.

Managing visitor expectations and informing visitors of trail closures and the reasons for and benefits of restoration would require the interpretive staff to create and distribute publications with information about the Grand Ditch breach restoration project and project area travel restrictions. The project area may be signed and information posted to inform visitors before entering the backcountry. The effort to implement information and education activities would take place within the current capabilities of division staff and may be a measurable increase in workload. This would result in a short-term, negligible to minor, adverse impact on park operations.

Cumulative Impacts

Cumulative effects of other plans and actions would be the same as described for Alternative A: long term, minor to moderate, and adverse. Alternative C would have effects related managing the restoration project. Managing contracts and contractors, conducting monitoring and evaluation activities, and managing and informing visitors would result in short-term, negligible to moderate adverse impacts on park operations.

Overall, the cumulative effects of other plans and actions combined with Alternative C would be long term, minor to moderate, and adverse. The contribution of Alternative C to the cumulative impacts would be short term and modest.

Conclusion

Alternative B would result in long-term, negligible to minor, adverse impacts from managing visitors, from providing information and education about the restoration activities, and from monitoring and evaluating the performance of restoration actions. It would also result in long-term, minor to moderate, adverse effects on park operations from managing contractors carrying out restoration actions.

Alternative B would make a modest adverse contribution to overall long-term, minor to moderate, adverse cumulative impacts on park operations. The contribution of Alternative C to the cumulative impacts would be short term and modest.

IMPACTS OF ALTERNATIVE D – THE NATIONAL PARK SERVICE PREFERRED ALTERNATIVE

Analysis

The effects of managing restoration activities, monitoring and evaluating restoration performance, and managing and informing visitors would be the same as described for alternative C.

Cumulative Impacts

Cumulative effects of other plans and actions would be the same as described for Alternative A: long term, minor to moderate, and adverse. Alternative D would have effects related managing the restoration project. Managing contracts and contractors, conducting monitoring and evaluation activities, and managing and informing visitors would result in short-term, negligible to moderate, adverse impacts on park operations.

Overall, the cumulative effects of other plans and actions combined with Alternative D would be long term, minor to moderate, and adverse. The contribution of Alternative D to the cumulative impacts would be short term and modest.

Conclusion

The impacts for managing restoration actions, monitoring and evaluating restoration performance, and managing and informing visitors would be the same as in alternative C.

The cumulative effects of other plans and actions combined with alternative D would be the same as alternative C: long term, minor to moderate, and adverse. The contribution of Alternative D to the cumulative impacts would be short term and modest.

IMPACTS OF ALTERNATIVE E – MAXIMUM RESTORATION

Analysis

The effects of managing restoration activities, monitoring and evaluating restoration performance, and managing and informing visitors would be the same as described for alternative C.

Cumulative Impacts

Cumulative effects of other plans and actions would be the same as described for Alternative A: long term, minor to moderate, and adverse. Alternative E would have effects related managing the restoration project. Managing contracts and contractors, conducting monitoring and evaluation activities, and managing and informing visitors would result in short-term, negligible to moderate, adverse impacts on park operations.

Overall, the cumulative effects of other plans and actions combined with Alternative E would be long term, minor to moderate, and adverse. The contribution of Alternative E to the cumulative impacts would be short term and modest.

Conclusion

The impacts for managing restoration actions, monitoring and evaluating restoration performance, and managing and informing visitors would be the same as in alternative C.

The cumulative effects of other plans and actions combined with alternative E would be the same as alternative C: long term, minor to moderate, and adverse. The contribution of Alternative E to the cumulative impacts would be short term and modest.

SUSTAINABILITY AND LONG-TERM MANAGEMENT

The consideration of long-term impacts and the effects of foreclosing future options are addressed in this section. The term “sustainability” refers to sections 102(2)(C)(ii), (iv), and (v) of the National Environmental Policy Act, not to the more recent context that includes features such as water conservation techniques and green building standards. The intent of this analysis is to identify sustainable actions that meet the needs of the present without compromising the ability of future generations to meet their needs.

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The intent of this determination is to identify whether any of the alternatives would result in trading the immediate use of the land for any long-term management possibilities or the productivity of park resources that would affect future generations. It is intended to determine whether each of the alternatives would be a sustainable action that could continue over the long term without generating unintended environmental problems.

Alternative A, the no action alternative, would rely on passive, natural restoration of the ecological and hydrologic processes in the area impacted by the 2003 Grand Ditch breach, as discussed earlier in this document. While passive restoration would allow for enhancement of vegetative cover and some debris stabilization, full recovery of some processes would not be possible. Alternative A would therefore not restore or enhance the long-term productivity of park resources in the project area.

Alternative B would include some restoration and would be a sustainable action that would not change the use of the project area. However, this alternative would rely predominantly on passive restoration and would therefore not significantly restore or enhance the long-term productivity of park resources in the project area, similar to alternative A.

Alternatives C, D, and E would be sustainable actions that would not change the use of the project area within Rocky Mountain National Park and consist of restoration activities that would enhance the long-term productivity of the project area for future generations. There would be some short-term, adverse environmental impacts on park resources, but these would only be implemented to support the restoration activities that would lead to an increase in long-term productivity.

ANY IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED SHOULD THE ALTERNATIVE BE IMPLEMENTED

The intent of this evaluation is to identify whether any of the alternatives would result in effects on resources that could not be changed over the long term or would be permanent. An effect on a resource would be irreversible if the resource could not be reclaimed, restored, or otherwise returned to its condition before the disturbance. Irretrievable commitments of resources are those that are lost for a period of time.

Alternative A would leave the site unstable, with headcuts and unstable banks causing long-term, irreversible and irretrievable soil loss; Alternative B may not involve irreversible or irretrievable commitments of resources. However, it is unknown whether the minimal work accomplished to zones 1b-4 would be sufficient to withstand high flows, making headcuts and banks vulnerable to long-term soil loss.

Under alternatives C, D, and E, impacts on soils, water quality, wetlands, and vegetation associated with restoration implementation fieldwork, such as debris removal and terracing, would be an irretrievable commitment of resources. The soils that would be covered by debris terraces and the removal of vegetation in order to develop these terraces would be removed from other productive purposes. However, once complete, the debris terraces would be stabilized and revegetated and the soils atop the terraces would be returned to near-natural productivity so that a long-term commitment of this resource would not occur. During restoration implementation fieldwork, debris removal and stabilization would result in an irretrievable commitment of vegetation, water quality, and wetlands, but these effects would be mitigated. Once restoration was complete, the wetland conditions would be enhanced, wetland species diversity would increase, and the effects of previous sedimentation would decrease. There would be no long-term commitment of these resources.

Traditionally, the use of building materials, such as concrete and metal, has been considered an irreversible commitment. However, modern sustainable design is developing construction techniques so that these materials can be completely disassembled and recycled at the end of their useful lives. Depending on the approach used to stabilize zone 1A under option 1 or 2, the commitment of materials might be classified as either as irreversible or as irretrievable. All four action alternatives would involve the irretrievable commitment of labor and fossil fuels to varying degrees.

ANY ADVERSE IMPACTS WHICH CANNOT BE AVOIDED SHOULD THE ACTION BE IMPLEMENTED

The intent of this determination is to identify whether any of the alternatives would result in impacts that could not be fully mitigated or avoided. NPS guidance states that the analysis should focus on those environmental issues that would involve major impacts if action were taken (NPS 2001).

There would be unavoidable impacts with all alternatives. Unavoidable adverse impacts would continue to occur under alternative A because slopes and streambanks would erode at unnatural rates, sediment would continue to be deposited in wetland areas, and hydrologic conditions would continue to deteriorate. Resources that would continue to be adversely affected at a moderate to major level include wilderness, water resources, wetlands, and vegetation. Under alternative B, unavoidable impacts on wilderness character and the natural soundscape would result from the use of mechanized equipment in zone 1A and the use of helicopters to transport equipment into the project area. These short-term impacts would be major and adverse. However, these short-term, adverse impacts would be necessary to achieve the long-term beneficial effects for these resources.

Unavoidable impacts under alternatives C, D, and E would all be similar. Restoration implementation fieldwork would result in temporary unavoidable impacts on wilderness character, natural soundscape, wildlife, and visitor use and experience from the presence and use of helicopters and machinery within the project area. Restoration activities such as debris stabilization and sediment removal would result in short-term, major, and unavoidable impacts on water resources and macroinvertebrate populations within the project area. However, all of these unavoidable impacts would be temporary and over the long term, restoration activities would improve hydrologic conditions and ecological services resulting in beneficial effects on these resources.

CHAPTER 5:

CONSULTATION AND COORDINATION

PUBLIC AND AGENCY INVOLVEMENT

THE SCOPING PROCESS

The National Park Service divides the scoping process into two parts: internal scoping and external (public) scoping. Internal scoping for this project involved discussions among NPS personnel regarding issues, management alternatives, mitigation measures, appropriate level of documentation, cooperating agency roles, available references and guidance, the purpose and need for the restoration, and other related dialogue.

Public scoping is the early involvement of the interested and affected public in the environmental analysis process. The public scoping process helps ensure that people have been given an opportunity to comment and contribute early in the decision-making process. For this environmental impact statement, project information was distributed to individuals, agencies, and organizations early in the scoping process, and people were given opportunities to express concerns or views and identify important issues or even other alternatives.

Taken together, internal and public scoping are essential elements of the National Environmental Policy Act planning process. The following sections describe the various ways the National Park Service conducted internal and public scoping for this environmental impact statement.

Internal Scoping

A formal internal scoping meeting was held on February 8, 2010 with the park interdisciplinary team. Field activities were conducted in the project area on June 21, 2010 and again on August 4, 2011 to familiarize team members with the area impacted by the 2003 Grand Ditch breach.

The meeting on February 8, 2010 was held at the Rocky Mountain National Park headquarters and included representatives of the National Park Service and the environmental impact statement contractor, Parsons. The goals were to present issues; describe purpose and need concepts; discuss preliminary alternatives; review research and surveys that have been conducted in the area; identify preliminary resource concerns; and discuss resource topics to be retained, dismissed, and evaluated in detail. Other scoping involved consultation with specialists on staff and identification of resource issues by NPS resource and operations personnel. The interagency planning team includes the National Park Service and Grand County. The National Park Service is the lead agency, and is responsible for all aspects of developing the environmental impact statement, including selection of the NPS preferred alternative and preparing a record of decision. Grand County has participated in developing the environmental impact statement.

This document has been reviewed by NPS subject matter experts from the Washington, DC, office (Natural Resources Stewardship and Science Directorate) on water quality, fluvial processes, wetland and riparian ecology, geomorphology, restoration ecology, natural sounds, and National Environmental Policy Act compliance.

Public Scoping

Public meetings and two newsletters kept the public informed and involved in the planning process for the environmental impact statement. A mailing list consisted of members of governmental agencies, Native American Tribes, nongovernmental groups, businesses, legislators, local governments, and interested citizens.

The notice of intent to prepare an environmental impact statement was published in the *Federal Register* (Federal Register, Volume 75, Number 52) on March 18, 2010.

Two pieces of correspondence were received on the first newsletter (Spring 2010) and approximately 110 comments were received through these correspondences and orally during the two public meetings held in Grand Lake and Fort Collins in June 2010. A total of 10 people attended these meetings.

Many of the public responses included inquiries regarding the natural revegetation that has already occurred or expressed concern over proposed revegetation strategies. Additional comments proposed restoration options for each zone. Concerns were raised regarding construction methods for restoration and sedimentation during and after restoration.

An alternatives workshop was held at McGraw Ranch in the park on August 4 and 5, 2010. Thirteen individuals, representing different disciplines from the park and the Resource Protection Branch of the NPS Environmental Quality Division attended this workshop and considered the public comments received in developing preliminary draft alternatives for restoration of the Grand Ditch breach. These draft alternatives were then presented to the public in the fall 2010 newsletter. During this phase of scoping the public was asked to provide input on the preliminary draft alternatives and to suggest additional restoration approaches. The National Park Service held two public meetings on the draft alternatives on October 12 and 14 in the same locations listed above, where a total of 18 people attended. Approximately 100 comments were received through letters, emails, online, and during the public meetings. A report summarizing the comments on the preliminary draft alternatives was made available to the public on the Park Planning, Environment, and Public Comment website.

More than half of the comments were in regards to the proposed alternatives and expressed support of or opposition to specific alternatives, as well as additional suggestions. Additional comments discussed the area impacted by the debris flow, concerns regarding the proposed area of analysis, and cumulative impacts. Many comments expressed support for alternative E.

With this input on the preliminary draft alternatives, the park staff and Grand County developed the final range of alternatives to be considered for analysis.

The draft environmental impact statement was released for public review on March 16, 2012 for a 60-day comment period. Respondents were encouraged to comment electronically on the NPS Planning, Environment, and Public Comment (PEPC) website, by letter, or in person at public meetings. The comment period closed on May 25, 2012.

The National Park Service held public meetings on the draft environmental impact statement on April 11 and 12, 2012. The public meetings were held to provide background information on the Grand Ditch breach and its impacts, to inform the public of the availability of the draft environmental impact statement, and to provide an opportunity to receive thoughts and views from the public. A total of seven members of the public attended the scoping meetings, three in Fort Collins and four in Grand Lake.

The NPS received a total of 10 response documents in addition to oral comments received at the public meetings. The documents submitted contained multiple individual comments or suggestions regarding the Grand Ditch breach restoration project.

CONSULTATION WITH OTHER AGENCIES, OFFICIALS, AND ORGANIZATIONS

Section 7 Consultation for Threatened and Endangered Species

The U.S. Fish and Wildlife Service concurred with an updated species list on March 15, 2013, which is found in appendix D of the FEIS. This letter did not identify that there was any critical habitat for any of the species of concern within the project area.

The analysis of special status species in chapter 4 determined that all effects of implementing the NPS preferred alternative would result in a section 7 judgment of "may affect, is not likely to adversely affect" for all of the species identified by the U.S. Fish and Wildlife Service. A Biological Assessment (BA) was included in the DEIS as appendix B.

On February 1, 2012, a letter was sent to the U.S. Fish and Wildlife Service transmitting the BA. A copy of the letter from the U.S. Fish and Wildlife Service that provided this information is in appendix D of the FEIS.

The U.S. Fish and Wildlife Service responded with a final biological opinion on September 6, 2012. The Service concurred with determination that the proposed project may affect but is not likely to adversely affect the Canada lynx. The Service also concluded that the project meets the criteria to rely on the Recovery Implementation Program Recovery Action Plan to offset depletion impacts and I not likely to jeopardize the continued existence of endangered fish species of the Upper Colorado River Basin.

Section 106 Consultation

Agencies that have direct or indirect jurisdiction over historic properties are required by Section 106 of the National Historic Preservation Act of 1966, as amended (16 USC 270, et seq.) to take into account the effect of any undertaking on properties eligible for listing in the National Register of Historic Places. To meet the requirements of 36 CFR 800, the National Park Service sent letters to the Colorado state historic preservation officer and the Advisory Council on Historic Preservation on January 31, 2012, inviting their participation in the planning process. Both offices were sent both of the newsletters with a request for comments.

The Colorado state historic preservation officer responded on February 22, 2012 to concur with a finding of no adverse effect to historic resources. A copy of this letter is provided in appendix D.

Under the terms of the 2008 programmatic agreement among the National Park Service, Advisory Council on Historic Preservation, and National Conference of State Historic Preservation Officers, the National Park Service will consult with federal, state, and local agencies, Indian tribes, and the private sector to ensure implementation of the National Historic Preservation Act and 36 CFR 800, the Advisory Council on Historic Preservation regulations implementing Section 106.

Tribal Consultation

The Cheyenne Arapaho Tribes of Oklahoma, Northern Arapaho Tribe, Southern Ute Indian Tribe, Ute Indian Tribe of the Uintah and Ouray Reservation, Ute Mountain Tribe of the Ute Mountain Reservation, and the White Mesa Tribe have traditionally been associated with lands that are now included within Rocky Mountain National Park. A copy of the initial scoping newsletter about the Grand Ditch Breach Restoration was mailed to these tribes in May 2010. No comments were received from the tribes. In January 2012 another letter was sent to the six affiliated tribes inviting input and offering to meet in person. No responses were received from the tribes. A representative copy of the January 2012 letters sent to all tribes is included in appendix D.

U.S. Army Corps of Engineers and Colorado Department of Public Health and the Environment

Under the Clean Water Act, Section 404, the U.S. Army Corps of Engineers is authorized to regulate the alteration of stream channels. According to Sections 303 and 402 of the Act, the State of Colorado and the Environmental Protection Agency are responsible for regulating and enforcing water quality standards and authorizing the discharge of pollutants under the National Pollutant Discharge Elimination Program. The U.S. Army Corps of Engineers and the Colorado Department of Public Health and the Environment were consulted about the restoration of stream channels and wetlands within the project area and necessary permits, and the U.S. Army Corps of Engineers was sent a formal scoping letter on Feb 1, 2012. The National Park Service will obtain all necessary permits for the project from the U.S. Army Corps of Engineers, the State of Colorado, and the Environmental Protection Agency.

U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency, Region 8 received a copy of the draft environmental impact statement in March of 2012. Pursuant to their responsibilities and authority under Section 102(2)(C) of the National Environmental Policy Act, 42 U.S.C. Section 4332(2)(C), and Section 309 of the Clean Air Act, 42 U.S.C. Section 7609, they provided an independent review and evaluation of the potential environmental impacts of the project. Based on their procedures, the U.S. Environmental Protection Agency did not have any objections to the preferred alternative. A copy of their letter, including their criteria, is included in appendix C.

LIST OF PREPARERS

The people identified in Table 5.1 were primarily responsible for preparing this environmental impact statement. The table includes their expertise, experience, and roles in preparing this document.

Table 5.1: Preparers and Contributors to the Environmental Impact Statement

Name	Title	Education	Experience
National Park Service			
Isabel Ashton	Ecologist	B.A. Environmental Biology Ph.D. Ecology and Evolutionary Biology	12 years
Ben Bobowski	Chief of Resource Stewardship	Ph.D.	20 years
Jim Cheatham	Biologist	B.S. Biology	16 years
Jeff Connor	Natural Resource Specialist	B.A. Wildlife Management and Ecology	35 years
Scott Esser	Ecologist	B.S. Conservation Biology	9 years
Kirsten Hardin	Facility Manager, Projects	M.S. Civil Engineering	10 years
John Mack	Branch Chief, Natural Resources	B.S. Biology M.S. Fish and Wildlife Management	22 years
Paul McLaughlin	Ecologist	M.S. Earth Resources	22 years
Suzanne Stutzman	Wilderness Coordinator, Intermountain Region, National Park Service	B.S. Master of Landscape Architecture	34 years
Mark VanMouwerik	Restoration Project Manager	B.S. Biology M.S. Environmental Health	16 years
Grand County			
Katherine Morris	Grand County Water Quality Specialist	B.A. English Literature M.S. Environmental Geochemistry	20 years

Name	Title	Education	Experience
Parsons			
Timberley Belish	Environmental Scientist	B.S. Biology M.S. Ecology and Evolution Responsible for planning scope, alternative development, general document writing and preparation	19 years
Bill Goosmann	Environmental Scientist	Responsible for preparation and impact analysis of soils	21 years
John Hoesterey	Project Manager and Public Involvement Specialist	B.A. Zoology M.S. Geography and Environmental Science Responsible for EIS team facilitation, public involvement, project management, and document review	34 years
Don Kellett	Wildlife Biologist / Environmental Scientist	B.S. Wildlife Biology Responsible for purpose and need, alternative development, and wildlife and natural resource impact assessments	19 years
Scott Lowry	Technical Editor	Ph.D. English Responsible for editing and formatting much of the EIS	16 years
Alexa Miles	Environmental Planner and Scientist	B.A. Environmental Studies Masters of Landscape Architecture Responsible for public and workshop planning, alternative development, general document writing and preparation, and graphics production	9 years
Aaron Sidder	Environmental Scientist	B.S. Environmental Science Responsible for preparation and impact analysis of the Wildlife and Special Status Species sections	4 years

Name	Title	Education	Experience
Bruce Snyder	Technical Director	B.S. Biology M.S. Wildlife Biology Responsible for technical direction for compliance with National Environmental Policy Act, NPS DO-12, and other NPS policies and guidelines for EIS content; project team support; addressing issues and analytical requirements	40 years
Seth Wilcher	Cultural Resource Specialist	B.S. History/Education M.H.P. Historic Preservation Responsible for cultural resources impact analysis	7 years

LIST OF RECIPIENTS

A postcard was mailed to the agencies, organizations, and businesses listed below as well as individuals who were listed on the project mailing list. The EIS was distributed only to those entities that requested a copy.

PUBLIC AGENCIES

City of Longmont

Colorado Department of Natural Resources

Colorado Division of Parks and Wildlife

Colorado Natural Heritage Program, Colorado State University

Colorado State Forest Service

Environmental Protection Agency

Environmental Protection Agency, Region 8

Estes Valley Recreation and Parks District

Grand County

Grand Lake Chamber of Commerce

Jackson County

Larimer County

Town of Estes Park

Town of Grand Lake

U.S. Army Corp of Engineers

U.S. Bureau of Reclamation

U.S. Department of Agriculture Forest Service

U.S. Fish and Wildlife Service

U.S. Forest Service, Sulphur Ranger District

U.S. Geological Survey

ELECTED OFFICIALS

United States Senate

Honorable Michael Bennet

Honorable Mark Udall

United States House of Representatives

Honorable Jared Polis

Colorado State Senate

Honorable Kevin Lundberg, District 15

Honorable Jeanne Nicholson, District 16

Honorable Jean White, District 8

Colorado House of Representatives

Honorable Randy Baumgardner, District 57

Honorable Claire Levy, District 13

Honorable B. J. Nikkel, District 49

Colorado County and Local Elected Officials

Boulder County Commissioners

Grand County Commissioner

Jackson County Commissioner

Larimer County Commissioner

Mayor, Town of Estes Park

Mayor, Town of Grand Lake

SCHOOLS, ORGANIZATIONS, AND BUSINESSES

American Alpine Club

American Lands Alliance

Audubon Society

Backcountry Parachutists

Biodiversity Associates

Biodiversity Conservation Alliance

Boulder Daily Camera

Boulder Outdoor Center

Boulder Public Library

Center for Native Ecosystems

Colorado Environmental Coalition

Colorado Fish and Wildlife Assistance

Colorado Historical Society

Colorado Mountain Club

Colorado Mountain School

Colorado Mule Deer Association

Colorado Natural Areas Program

Colorado Open Lands

Colorado Wildlife Heritage Foundation

The Conservation Fund

Continental Divide Trail Alliance

Continental Divide Trail Society

Denver Post

Environmental Defense

Estes Park Public Library

Estes Park Trail-Gazette

Estes Valley Land Trust

Fort Collins Coloradoan

Fort Collins Public Library

Grand Lake Metro Recreation District

Great Old Broads for Wilderness

Greater Allenspark Community

International Mountain Bicycling Association

Juniper Library

League of Women Voters

Legacy Land Trust

Longmont Times

Longmont Public Library

Loveland Public Library

Loveland Reporter-Herald

Middle Park Land Trust

National Parks Conservation Association

The Nature Conservancy

Northern Colorado Water Conservancy District

Poudre River Trust

Rocky Mountain Elk Foundation

Rocky Mountain Nature Association

Sierra Club

St. Vrain and Left Hand Water Conservancy District

Sky-Hi News

Trout Unlimited

The Trust for Public Land

Upper North St. Vrain Landowners

The Water Supply and Storage Company

The Wilderness Society

Wilderness Watch

Wildlands CPR

YMCA of the Rockies

TRADITIONALLY ASSOCIATED INDIAN TRIBES

Cheyenne Arapahoe Tribes of Oklahoma

Northern Arapahoe Tribe

Southern Ute Indian Tribe

Ute Indian Tribe of Uintah and Ouray Reservation

Ute Mountain Tribe of the Ute Mountain Reservation

White Mesa Ute Tribe

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CHAPTER 6:

REFERENCES

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GLOSSARY OF TERMS

Abiotic: Characterized by the absence of life or living organisms.

Acre-foot: The volume of water required to cover 1 acre of land to a depth of 1 foot. It equals 325,851 gallons.

Active channel: The portion of the river and floodplain inundated at normal winter floodflows.

Adaptive management: A principle that incorporates monitoring and research into conservation actions. Specifically, it is the integration of planning, management, and monitoring to test assumptions in order to adapt and learn.

Aggradation: To fill and raise the level of the bed of a stream by deposition of sediment. Severe aggradation of stream channels decreases water depth and flow and can result in excessive temperatures or decreased dissolved oxygen during summer. Aggradation can also cause a lack of cover and smothering of coarse-grained substrates. It can also contribute to channel avulsion.

Alluvial: Of or pertaining to a deposit of sand, mud, or other materials formed by flowing water.

Alluvial fan: A fan-shaped accumulation of alluvium deposited at the mouth of a ravine or at the juncture of a tributary stream with the main stream.

Aquatic habitat: An environment consisting of water where an organism or ecological community normally lives or occurs.

Attenuation: Reduction of peak flow and increased duration of a flow event.

Avulsion: the process of an abrupt change in a stream channel's location in a floodplain or valley from one position to another.

Bankfull discharge: The discharge corresponding to the stage at which flow begins to spill onto the active floodplain.

Biodiversity: The diversity of plant and animal species in an environment.

Biota: The animal and plant life of a particular region, habitat, or geological period.

Braided channel: A stream characterized by flow within several channels, which successively meet and redivide. Braiding may be an adjustment to a sediment load too large to be carried by a single channel.

Breach: An opening, a tear, or a rupture.

Channel: A natural or artificial waterway of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks that serve to confine the water.

Channel morphology: The structure and form of a stream channel.

Channel stability: A relative measure of the resistance of a stream to erosion. Stable streams do not change markedly in appearance from year to year. Assessing stability helps determine how well a stream will adjust to and recover from changes in flow or sediment transport.

Compaction: The compression of soil layers reducing the ability of plants to survive, reducing water infiltration capacity, and increasing water runoff.

Critical habitat: As defined in the Endangered Species Act (1973), pertains to: "(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of this Act, upon a determination by the Secretary (of the U.S. Department of the Interior) that such areas are essential for the conservation of the species."

Cumulative impact: As defined by the Council on Environmental Quality, the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Debris: In terms of this document, debris is defined as inorganic material that was carried and deposited by the 2003 Grand Ditch breach.

Degradation: The lowering of the bed of a stream. Degradation of stream channels can lead to a lowering of the water table and consequent dessication and loss of riparian vegetation.

Deposition: The geological process by which material is added to a landform or land mass. Fluids such as wind and water, as well as sediment gravity flows, transport previously eroded sediment, which, at the loss of enough kinetic energy in the fluid, is deposited, building up layers of sediment.

Desired condition: The desired attributes that management seeks to attain.

Ecological reference condition: A comparative reference point to equivalent environments elsewhere that fulfills all requirements necessary to develop and establish its fauna and flora under undisturbed conditions.

Ecological services: The multitude of resources and processes that are supplied by natural ecosystems benefitting the biota. Collectively, these benefits are known as ecological services.

Ecosystem: A system formed by the interaction of a community of organisms with their environment.

Endangered: Defined by U.S. Fish and Wildlife Service and listed in the Federal Register as being in danger of extinction.

Erosion: Natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface.

Exclosure: A fenced area designed to exclude one or more species.

Exotic: As described by NPS Management Policies (2006), a species that did not evolve in concert with the species native to an ecosystem, and occupies or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities. Sometimes called "non-native," "alien," or "invasive."

Extinction: Disappearance from the earth.

Extirpation: Disappearance from a specified geographic area.

Floodplain: A relatively flat, depositional surface adjacent to the channel, formed by the river under its present climate and sediment load, and that is overflowed during moderate peak flow events

Flow: To move or run smoothly with unbroken continuity, as in the manner characteristic of a fluid.

Fluvial: Of, relating to, or occurring in a river.

Forb: Nonwoody, broad-leaf, flowering plant that is neither a grass nor grasslike.

Geomorphology: The study of the classification, description, nature, origin and development of landforms and their relationships to underlying structures; also the history of geologic changes as recorded by these surface features.

Geotextile: A strong synthetic fabric used in civil engineering, as to retain an embankment.

Ground penetrating radar: A geophysical method that uses radar pulses to image the subsurface.

Herbaceous: A plant with no persistent woody stem above ground; characteristics of that of an herb.

Hydraulic: Of, involving, moved by, or operated by a fluid, especially water, under pressure.

Hydric: Relating or adapted to a wet but not flooded habitat.

Hydrologic: Pertaining to the occurrence, circulation, distribution, and properties of the water.

Hydroperiod: The number of days per year than an area of land is dry or the length of time that there is standing water at a location.

Impairment: To cause to diminish, as in strength, value, or quality.

Mechanized equipment: Motor propelled equipment.

Native: As described by NPS Management Policies (2006), pertains to a species that has occurred or now occurs as a result of natural processes on lands designated as units of the national park system.

Perennial stream: A stream or river that has continuous flow in parts of its bed all year round during years of normal rainfall.

Pool-riffle complex: A water habitat composed of riffles (characterized by water flowing rapidly over a coarse substrate) and pools (deeper areas of water associated with riffles).

Riparian: Pertaining to, situated or dwelling on the bank of a river, stream or other body of water. For this assessment, it refers to a certain distance from the top of a streambank or riverbank.

Scrub: A large area covered with low trees and shrubs.

Sediment: Naturally occurring material that is broken down by processes of weathering and erosion, and is subsequently transported by the action of fluids such as wind, water, or ice, and/or by the force of gravity. In terms of this document, sediment includes all non-organic material that has been relocated throughout the project area subsequent to the 2003 breach.

Sedimentation: The deposition or accumulation of mineral or organic matter by water, air, or ice.

Soil nailing: A construction technique that can be used as a remedial measure to treat unstable natural soil slopes. The technique involves the insertion of relatively slender reinforcing elements into the slope. Solid bars are usually installed into pre-drilled holes and then grouted into place.

Stabilization: To make stable or steadfast.

Stage (as in river or stream stage): The level of the water surface of a river or stream above an established zero point.

Step-pool: A sequence in a creek or river composed of channel-spanning pools and boulder/cobble steps that cause subcritical flow in the pool and supercritical flow over the steps. They occur in gradients in the range of 5 to 20%.

Stream (includes creeks and rivers): A body of water that flows at least periodically or intermittently through a bed or channel having banks and that supports fish or other aquatic life. This includes watercourses having a surface or subsurface flow that supports or has supported riparian vegetation.

Streambank: The portion of the channel cross section that restricts lateral movement of water at normal water levels. The bank often has a gradient steeper than 45 degrees and exhibits a distinct break in slope from the stream bottom.

Stream morphology: The size and shape of the stream, typically described by longitudinal slope profile, cross-sectional dimension, and meander pattern.

Threatened: Defined by U.S. Fish and Wildlife Service and listed in the Federal Register as likely to become endangered within the foreseeable future (see "endangered").

Watershed: The region or area drained by a river, stream, etc.

Wetland function: A process or series of processes that take place within a wetland. These include the storage of water, transformation of nutrients, growth of living matter, and diversity of wetland plants.

Woody material: Dead woody material, in various stages of decomposition that is not self-supporting.

Zoonotic disease: Any disease or infection that is naturally transmissible from humans to other vertebrate animals and vice versa.

INDEX

APPENDIX A: MEMORANDUM OF UNDERSTANDING BETWEEN THE NATIONAL PARK SERVICE AND GRAND COUNTY

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Memorandum of Understanding between The United States Department of the Interior National Park Service Rocky Mountain National Park and Grand County Colorado

This Memorandum of Understanding (hereinafter "MOU") is entered into by and between the National Park Service (hereinafter "NPS"), United States Department of the Interior, acting through the Superintendent of Rocky Mountain National Park, and Grand County, Colorado (hereinafter "County"), acting through its Board of Commissioners. When referred to collectively, the two entities shall hereinafter be called the "Parties."

ARTICLE I – OBJECTIVES

The objective of this MOU is to provide a framework to encourage close coordination between the Parties to support the completion of the Grand Ditch Breach Restoration Environmental Impact Statement ("EIS") under the National Environmental Policy Act ("NEPA") and other environmental laws, regulations, and Executive Orders that apply to the NPS, in order to develop an environmentally responsible project while preventing project delays. This cooperation will facilitate a coordinated approach that ensures sound decisions based on concurrent reviews and serves the mutual interests of the Parties and the public.

The NPS, under the laws of the United States and regulations of the Department of the Interior, is responsible for the management of lands within the areas under its administration. Included is the re-establishment of natural functions and processes in human-disturbed components of natural systems in parks unless otherwise directed by Congress.

Pursuant to Colorado law, the County has authority over land use planning, development, and environmental protection. The County also is an implementing agency under the Regional Water Quality Management Plan adopted under Section 208 of the Clean Water Act. The County has a particular interest in maintaining and improving water quality in Grand Lake, Shadow Mountain Lake, and Lake Granby (collectively known as the Three Lakes), all located outside, but in close proximity to, the boundary of Rocky Mountain National Park. The County has a Water Quality Specialist on staff.

The above Parties have interests and responsibilities in protecting water quality. Efforts to ensure the protection of water quality will be of mutual benefit to the Parties in achieving their goals and performing their public service responsibilities.

This MOU identifies the roles of the NPS and the County in the preparation of analyses and documentation required by NEPA and other environmental laws, regulations, and Executive Orders. It establishes the lead and cooperating agencies, the responsible entity for the preparation of the EIS, and establishes a response period among the listed entities for consultation, coordination, and concurrence in project requirements. Additional MOUs or other agreements may be developed to address particular issues or other needs to further the intent of this MOU.

Nothing in this agreement is intended to restrict the Parties' ability to exercise their respective authorities as provided for in federal and state laws.

ARTICLE II – BACKGROUND

The goal of the Grand Ditch Breach Restoration is to restore the hydrological processes, ecological services, and wilderness character of the area in the upper Kawuneeche Valley of Rocky Mountain National Park impacted by the 2003 Grand Ditch breach. One of the restoration project's objectives is to restore water quality in the affected area and downstream. Any ground-disturbing restoration work will be done in compliance with the Clean Water Act, Colorado Department of Public Health and Environment regulations and all other applicable water quality regulations and best management practices.

The NPS is now in a multiyear process to complete the EIS, which will guide the restoration of the breach-impacted area. The EIS will evaluate various alternatives for accomplishing the restoration (including a no action alternative), it will evaluate the beneficial and adverse impacts associated with the various restoration alternatives, and it will provide a means for the public to participate in the review and decision making process. With this project, the NPS is required to comply with NEPA and other environmental laws, regulations, and Executive Orders.

ARTICLE III - AUTHORITY

The general authority for this agreement is contained within the NPS Legislative Authority found in 16 USC. §§ 1-3

Other NPS authorities include:

42 U.S.C. § 4331(b), which states that the federal government shall use all practicable means to improve and coordinate federal plans, functions, programs and resources to, inter alia, enhance the quality of the environment.

40 C.F .R. § 1500.5, which states that regulations implementing NEPA shall emphasize interagency cooperation early in the environmental review process.

40 C.F.R. § 1501.5, which states that if more than one agency is involved in the same action, one agency shall be designated a lead agency that will supervise the preparation of an environmental document. The other agencies are identified as cooperating agencies. The involved agencies shall determine by MOU which agency shall be lead and which shall be cooperating and shall resolve this issue so as not to cause delay.

40 C.F.R. § 1501.5(c), which states a cooperating agency may, in response to a lead agency's request for assistance in preparing the environmental document, defer to the lead agency in preparing such document where agency program commitments preclude involvement.

40 C.F.R. § 1508.5, which states that a local agency may be designated as a cooperating agency when that agency has jurisdiction by law or special expertise with respect to any environmental impact resulting from the action being proposed. And within the State of Colorado authority:

Section 29-20-101 et seq. of the Colorado Revised Statutes, which provides broad authority to the County to plan and regulate land use within its jurisdiction and protect the environment.

ARTICLE IV – STATEMENT OF WORK

To facilitate preparation of the EIS, the Parties hereby commit as follows:

- NPS - with respect to oversight of the EIS, the NPS will serve as lead agency and will coordinate all project review.

- The County will serve as the cooperating agency by means of its special expertise as it relates to water quality and other potential environmental impacts and benefits of the project.

In the spirit of cooperation and collaboration, and with the mutual understanding that this is a flexible working agreement among the signatory agencies, we hereby commit to the following responsibilities:

A. The NPS will:

1. manage the scoping process, prepare the Draft EIS, the Final EIS, and Record of Decision, and is the entity ultimately responsible for compliance with NEPA

2. provide project information including study results to the County

3. invite the County to coordination meetings and invite the County to attend or participate in other meetings/workshops/conference calls of interest to the County, including those held to develop/analyze practicable alternatives

4. consult with the County on technical studies related to water quality and related environmental impacts in the watershed

5. organize joint field reviews and schedule cooperating agency meetings

6. provide the County with the opportunity to review and comment on preliminary draft documents and reports, analyses and study results, comment letters on the draft and final EISs that are specific to County data and impacts, and mitigation proposals; promptly inform the County of all schedule changes relative to comment deadlines

    a. The NPS shall provide the County ten (10) working days to review and comment on draft documents and technical reports sent to the County for review

    b. The NPS shall provide the County thirty (30) days for review and comment on the Draft EIS sent to the County for review prior to commencement of the public comment period

7. use the County's special expertise to the maximum extent possible, consistent with NPS responsibilities as the lead agency

8. identify the County in the EIS as a cooperating agency and summarize its roles and responsibilities as a cooperating agency

B. Grand County will:

1. participate in the scoping process, which helps define and frame the issues to be addressed in the NEPA document

2. develop information and prepare environmental analyses (upon request of the lead agency) for portions of the EIS over which the cooperating agency has special expertise.

In particular, provide information and staff expertise on water quality in the North Fork of the Colorado River downstream of the park.

3. contribute staff support and other resources at the lead agency's request to enhance the NEPA team's interdisciplinary capability. In particular, attend Grand Ditch Breach Restoration Interdisciplinary Team meetings involving water quality issues and related environmental issues.

4. share freely with the NPS any information and data relevant to the NEPA analysis, thereby facilitating rational, fact-based decision making

5. review and comment on relevant documents and sections of the Draft Grand Ditch Breach Restoration EIS prior to public release

6. provide written comments on all documents it reviews within the time period specified in Subsection IV.A.6 of this MOU

7. not release any predecisional draft documents to the public or other parties unless mutually agreed to by NPS and the County or required through the Freedom of Information Act or comparable process, or through the County's dissemination of material as an approved part of the NEPA process

8. rely on its own funds to support its participation in the EIS

9. promptly advise the NPS if its needs are not being met.

10. retain the right to comment on all issues related to the EIS through the normal public review and comment process

ARTICLE V – TERM OF MEMORANDUM OF UNDERSTANDING

This MOU will be effective as of the date of final signature and shall remain in effect until a decision document has been signed by the Regional Director, Intermountain Region of the NPS, unless it is terminated earlier by one of the parties pursuant to Article VII that follows.

ARTICLE VI – KEY OFFICIALS

A. Key officials are essential to ensure maximum coordination and communication between the Parties and the work being performed. They are:

1. Key Grand County Official

   Lurline Underbrink Curran
   County Manager'
   P.O. Box 239
   Hot Sulphur Springs, CO 80451

2. Key National Park Service Official

   Vaughn Baker
   Superintendent
   Rocky Mountain National Park
   Estes Park, CO 80517

3. Agreements Technical Representative

   Lawrence H. Gamble
   Chief of Planning and Compliance
   Rocky Mountain National Park
   Estes Park, CO 80517

B. **Communications** - The County will address any communication regarding this MOU to the Agreements Technical Representative. Communications that relate solely to routine operational matters described in this MOU may be sent only to the superintendent.

C. **Changes in Key Officials** - Should either Party (NPS or the County) make a permanent change in a key official, the agency will provide written notice to the other party reasonably in advance of the change. Any permanent change in key officials will require modification of this MOU.

ARTICLE VII – MODIFICATION AND TERMINATION

A. This MOU may be modified only by a written instrument executed by the Parties.

B. Either Party may terminate this MOU by providing the other party with thirty (30) days advance written notice. In the event that one Party provides the other Party with notice of its intention to terminate, the Parties will meet promptly to discuss the reasons for the notice and to try to resolve their differences.

1. Either party to this MOU may voluntarily terminate its involvement in this agreement with proper written notice to the other party.

2. Failure on the part of either party to abide by the above terms shall be grounds for termination of this agreement.

ARTICLE VIII – STANDARD CLAUSES

A. **Civil Rights**

During the performance of this MOU, the participants agree to abide by the terms of U.S. Department of the Interior - Civil Rights Assurance Certification, non-discrimination and will not discriminate against any person because of race, color, religion, sex, or national origin. The participants will take affirmative action to ensure that applicants are employed without regard to their race, color, sexual orientation, national origin, disabilities, religion, age, or sex.

B. **Promotions**

The County will not publicize, or otherwise circulate, promotional material (such as advertisements, sales brochures, press releases, speeches, still and motion pictures, articles, manuscripts or other publications) which states or implies NPS employee endorsement of a product, service, or position which the County represents. No release of information relating to this MOU may state or imply that the NPS approves of the County's position or work product.

C. This agreement is subject to annual appropriations by the Grand County Board of County Commissioners.

D. Nothing contained herein shall be construed as a waiver or partial waiver of Grand County's Governmental Immunity, C.R.S. 24-10-101, et seq., as may be amended from time to time.

E. **Third-Party Beneficiary**

The parties do not intend to create in any other individual or entity the status of third-party beneficiary, and this MOU shall not be construed so as to create such status. The rights, duties, and obligations documented in this MOU shall operate only between the parties to this agreement, and shall inure solely to the benefit of the parties to this MOU. The provisions of this MOU are intended only to assist the parties in determining and performing their obligations under this MOU. The parties to this MOU intend and expressly agree that only parties signatory to this MOU shall have any legal or equitable right to seek to enforce this MOU, to seek any remedy arising out of a party's performance or failure to perform any term or condition of this MOU, or to bring an action for the breach of this MOU.

F. Nothing in this MOU will abridge or amend the authorities and responsibilities of NPS and the County on any matter under their respective jurisdictions. The County will retain the right to comment on all issues related to the EIS, including those in dispute, through the normal public review and comment process.

ARTICLE IX – SIGNATURES

IN WITNESS WHEREOF, the Parties hereto have executed this MOU on the date(s) set forth below.

FOR THE NATIONAL PARK SERVICE:

Signature: Vaughn Baker

Name: Vaughn Baker

Title: Superintendent, Rocky Mountain National Park

Date: 6-10-11

FOR GRAND COUNTY:

Signature: Gary Bumgarner

Name: Gary Bumgarner

Title: Chairman, Grand County Board of County Commissioners

Date: 6/6/11

Attest: Sara L. Rosene

Sara L. Rosene, Clerk and Recorder

Joanna L. Fuke Deputy Clerk

APPENDIX B: BIOLOGICAL ASSESSMENT

Rocky Mountain National Park

Colorado

Grand Ditch Breach Restoration Environmental Impact Statement

Biological Assessment
January 2012

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BIOLOGICAL ASSESSMENT
GRAND DITCH BREACH RESTORATION ENVIRONMENTAL IMPACT STATEMENT
ROCKY MOUNTAIN NATIONAL PARK, COLORADO

Location: Grand County, Colorado

Township 6 North, Range 75 West of the 6th Prime Meridian, Sections 30 and 31

U.S.G.S. 7.5' Fall River Pass topographic quadrangle (1977)

Contact Person: Ben Bobowski, NPS **Phone Number:** 970-586-1350

INTRODUCTION

The purpose of this biological assessment is to determine whether the actions proposed in the preferred alternative of the Draft Grand Ditch Breach Restoration / Environmental Impact Statement for Rocky Mountain National Park may affect any of the federally listed endangered, threatened, proposed or candidate species identified on the NPS-unit specific *Endangered Species Act (ESA) Endangered, Threatened, and Candidate Species List for Rocky Mountain National Park* (see Appendix A). The U.S. Fish and Wildlife Service concurred with this Rocky Mountain National Park-specific species list on April 7, 2011. The species presented in Table 1 include species on the list that may potentially be affected by the Grand Ditch restoration. This biological assessment is prepared in accordance with legal requirements set forth under Section 7 of the Endangered Species Act [16 USC 1536 (c)] and follows the standards established in the National Park Service's Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision-making, as well as National Park Service *Management Policies* 2006. Analysis of effects in this biological assessment is based upon the analyses of special status species in the Draft Rocky Mountain National Park Grand Ditch Breach Restoration Environmental Impact Statement (EIS). For additional analyses of effects to state-listed species and state species of concern, please refer to the EIS.

Based on the analyses of the effects of the preferred alternative (referred to as the proposed action in this biological assessment) on special status species, summarization of determinations of effect for federally listed species in Rocky Mountain National Park are as follows:

- *May affect, not likely to adversely affect* – Canada lynx and wolverine.
- *No effect* – Colorado pikeminnow, bonytail, greenback cutthroat trout, humpback chub, pallid sturgeon, razorback sucker, least tern (interior population), Mexican spotted owl, piping plover, whooping crane, yellow-billed cuckoo, Preble's meadow jumping mouse, Colorado butterfly plant, and Ute ladies'-tresses orchid.

There would be no modifications to any designated critical habitats as a result of the proposed action.

FEDERALLY LISTED ENDANGERED, THREATENED, PROPOSED, AND CANDIDATE SPECIES

The species considered in this document are those federally listed as endangered, threatened, proposed, or candidate species that potentially occur in Rocky Mountain National Park and areas that could be affected by the park's Grand Ditch breach restoration, as identified by the *Endangered Species Act (ESA) Endangered, Threatened, and Candidate Species List for Rocky Mountain National Park*. These species are collectively referred to as special status species. The EIS includes state-listed species in the analyses of potential effects; however, this biological assessment only addresses federally listed, proposed, or candidate species. Please refer to the EIS for an assessment of effects on state-listed species. The species considered for this biological assessment are presented in Table 1.

Table 1: Endangered, Threatened, Proposed, and Candidate Species with Potential to be Affected by the Grand Ditch Breach Restoration

Common Name	Scientific Name	Status
Fish		
Colorado pikeminnow*	*Ptychocheilus lucius*	FE
Razorback sucker*	*Xyrauchen texanus*	FE
Bonytail *	*Gila elegans*	FE
Humpback chub*	*Gila cypha*	FE
Birds		
Yellow-billed cuckoo	*Coccyzus americanus*	FC
Mammals		
Canada lynx	*Lynx canadensis*	FT
Wolverine	*Gulo gulo luscus*	FC

Key to Status: FE = federally endangered; FT = federally threatened; FC = federal candidate for listing
*These fish species are found in designated critical habitat downstream in the Colorado River.

CRITICAL HABITAT

None of the special status species that may be affected by the Grand Ditch breach restoration project have designated critical habitat in Rocky Mountain National Park (the Canada lynx does have designated critical habitat, but none in Colorado [USFWS 2009]). Although critical habitat has been designated for four fish species found downstream in the Colorado River (USFWS 1994), the critical habitat for these species lies outside the park and the area affected by the proposed action, thus the proposed action would not affect these species in their respective federally designated critical habitats. Specifically, actions associated with restoration would not have downstream effects beyond Grand Lake, Shadow Mountain Reservoir, or Lake Granby. There are no designated critical habitats for the Mexican spotted owl, yellow-billed cuckoo, or wolverine within Rocky Mountain National Park, nor would any designated critical habitat for these species outside the park be affected by actions associated with the restoration actions.

CONSULTATION TO DATE

Participating Agencies

Development of the EIS involved cooperation and consultation with multiple agencies at various levels of participation. The National Park Service is the lead agency and is responsible for all aspects of developing the EIS, including selection of a preferred alternative, as well as preparation of a record of decision and this biological assessment. Grand County is a cooperating agency, while consultation has been ongoing with the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and the Colorado State Historic Preservation Office.

Current Management Direction

Current management direction for Rocky Mountain National Park is guided by its 1976 Master Plan. The master plan established guidelines for the overall use, preservation, management, and development of the park. The 1976 plan included the following management objective, relative to the goals of restoration efforts:

> To provide management for the soil, water, flora, and fauna, native to this portion of the Rocky Mountains, so as to minimize the impact of man, and where desirable and feasible restore those ecosystems altered by man. Restoration will be aimed at presenting as close an approximation of primitive conditions as possible.

Other ongoing plans occurring within the park and region that may affect or guide NPS decisions made for restoring the areas affected by the Grand Ditch breach were also considered in development of the EIS. In Rocky Mountain National Park, these include the 2006 Vegetation Restoration Management Plan (version 2), the 2001 Backcountry Wilderness Management Plan, the 2004 Fire Management Plan, and the 2002 Wildland-Urban Interface Fuels Management Environmental Assessment. Activities associated with the proposed action will be consistent with these management plans.

Nearby U.S. Forest Service lands (Arapaho and Roosevelt National Forests) have developed land and resource management plans that guide resource management activities, including vegetation restoration. These plans are as follows: Arapaho and Roosevelt National Forests and Pawnee National Grassland 1997 Revision of the Land and Resource Management Plan and A Strategy for Accelerated Watershed/Vegetation Restoration on the Arapaho and Roosevelt National Forests and Pawnee National Grassland (2004).

In May 2005, the Colorado Wildlife Commission adopted the recommendations of the Colorado Wolf Management Working Group for management of wolves that may naturally migrate to Colorado. While there are uncertainties about the management authority for wolves, for the purposes of this analysis, it is foreseeable that the state wolf management plan would be implemented on land around the park within the 20-year lifespan of the Grand Ditch breach restoration.

DESCRIPTION OF THE PROPOSED ACTION

The Grand Ditch is located along the eastern slope of the Never Summer Range, within the Kawuneeche Valley, which serves as the upper most portion of the Colorado River watershed. On May 30, 2003 a breach along the Grand Ditch caused a failure of the ditch, which initiated gully erosion on the hillslope below the ditch. The resulting debris flow entered Lulu Creek and continued downstream to the Colorado River. A debris fan was deposited at the confluence of Lulu

Creek and the Colorado River. Evidence of extensive injury to vegetation communities and in-channel and floodplain erosion and deposition resulting from reworking of the debris flow material is prominent for at least 1.5 miles downstream to the lower end of the Lulu City wetland.

The focus of this EIS is the area of the Upper Kawuneeche Valley impacted by the May 30, 2003 Grand Ditch breach event. The site is located within designated wilderness in the northwest region of Rocky Mountain National Park (see figures 1.1. 1.2, and 1.3). The area of impact refers to the area that was directly impacted by the 2003 breach event. The Grand Ditch itself is owned and operated by the Water Supply and Storage Company and has a right of way through Rocky Mountain National Park. This biological assessment does NOT include any actions related to the operation, management, or repair of the Grand Ditch.

Damages caused by the 2003 Grand Ditch breach event affected four zones, as defined by the NPS in various restoration planning activities (Cooper 2007), and include the following (see figure 1.4):

Damages by Zone

Zone 1 (including Zone 1A and Zone 1B). This zone extends from the site of the breach along Grand Ditch downstream to the eroded gully's junction with Lulu Creek. The breach resulted in the formation of a large gully and the erosion of approximately 47,600 cubic yards from the hillslopes below the breach. This large gully possesses steep, unstable sides and a steep slope. Prior to the breach the slopes below the previously disturbed ditch were vegetated by upland forest, dominated by subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), and lodgepole pine (*Pinus contorta*). The forest floor was largely dominated by grouse whortleberry (*Vaccinium scoparium*).

Within zones 1A and 1B, the total area of disturbance is approximately 2.3 acres, however, approximately 1.0 acre was previously disturbed by activities associated with the Grand Ditch. Significant tree loss in this zone resulted in a 100% loss of ecological services, including wildlife habitat, soil stability, and aesthetic quality (Cordova 2006).

Zone 2. This zone includes Lulu Creek from its confluence with the eroded gully formed by the breach event to its confluence with the Colorado River. The landforms, hydrology, and vegetation in zone 2 were impacted by the Grand Ditch breach. The vegetation within zone 2 was characterized by upland forest with subalpine riparian vegetation along the stream banks and floodplains. Vegetation loss was very high in the riparian area while extensive injury to the hillslope spruce and fir forest also occurred. The natural stream channel of Lulu Creek was severely altered by the breach event. Conditions immediately following the breach event consisted of only a few reaches of a defined stream channel and no remnants of riparian vegetation. In about 6 acres of zone 2, 100% of the riparian and upland habitats have been destroyed and approximately 2.4 acres in the buffer area experienced a 25 to 50% injury to understory vegetation (Cordova 2006). The combined impacts have resulted in 89% loss of services over the approximate 8.5 acres (Cordova 2006).

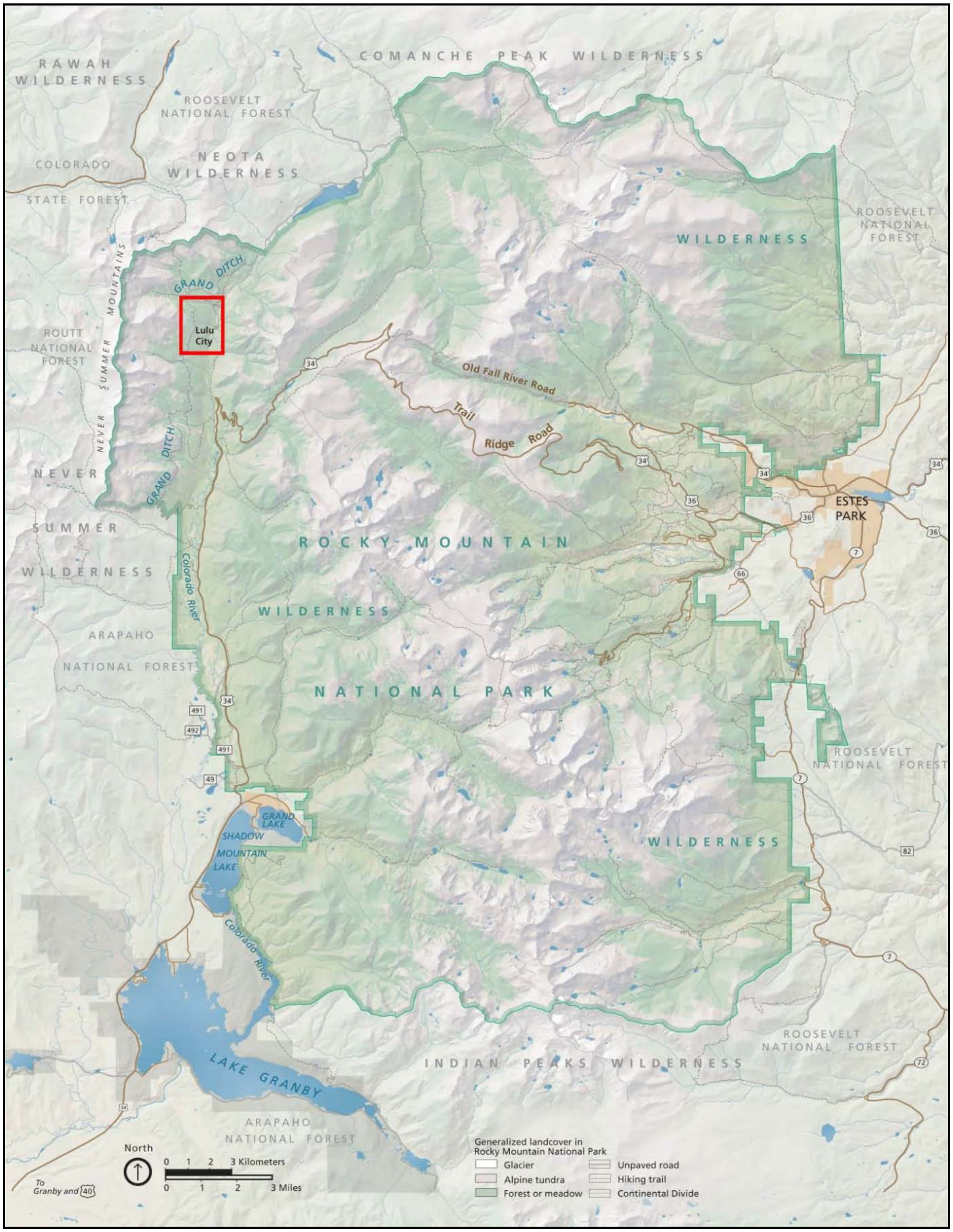

Figure 1.1: Rocky Mountain National Park and the area affected by the Grand Ditch breach

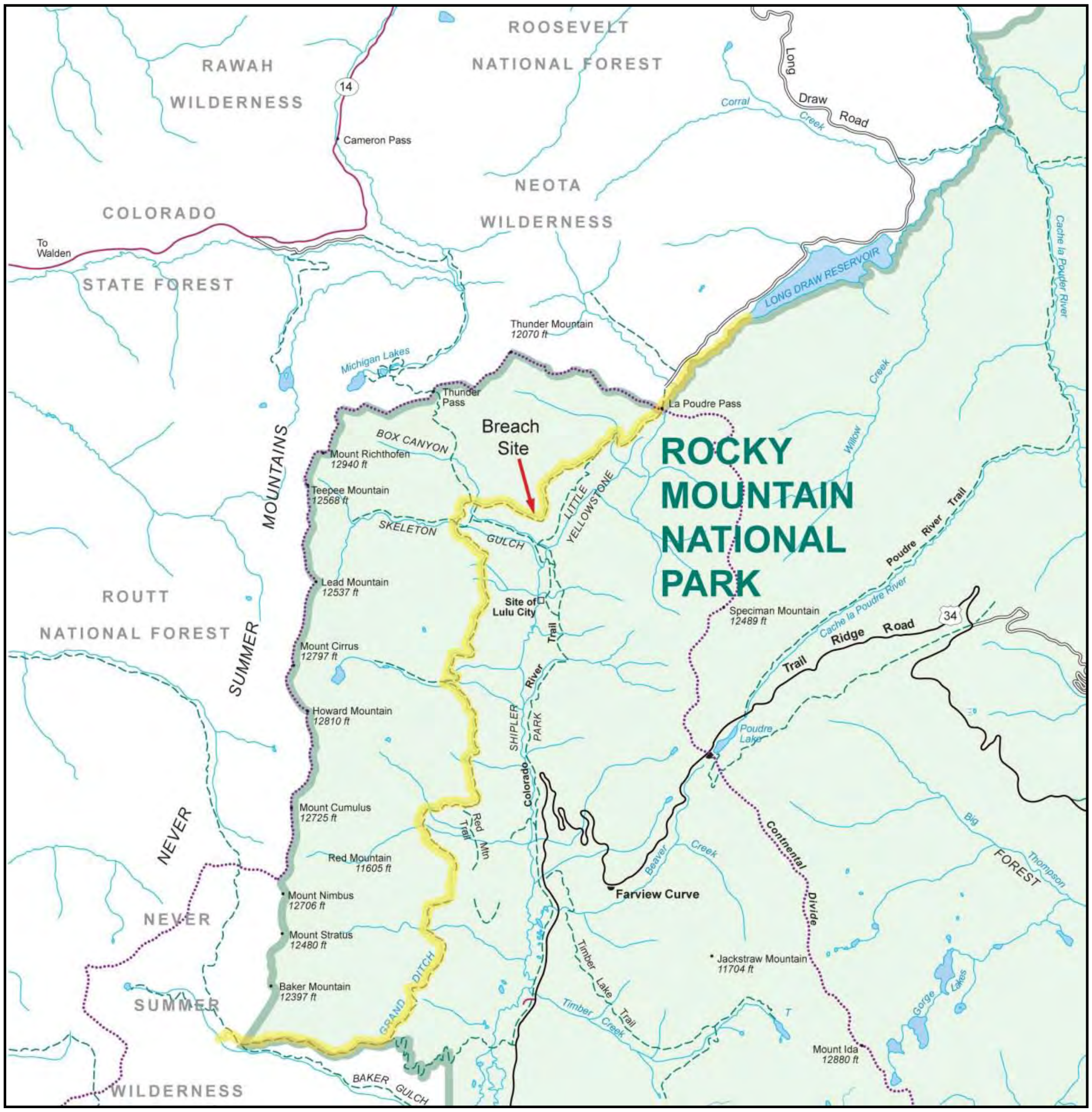

Figure 1.2: Location of the Grand Ditch

Figure 1.3: Grand Ditch breach area within Rocky Mountain National Park

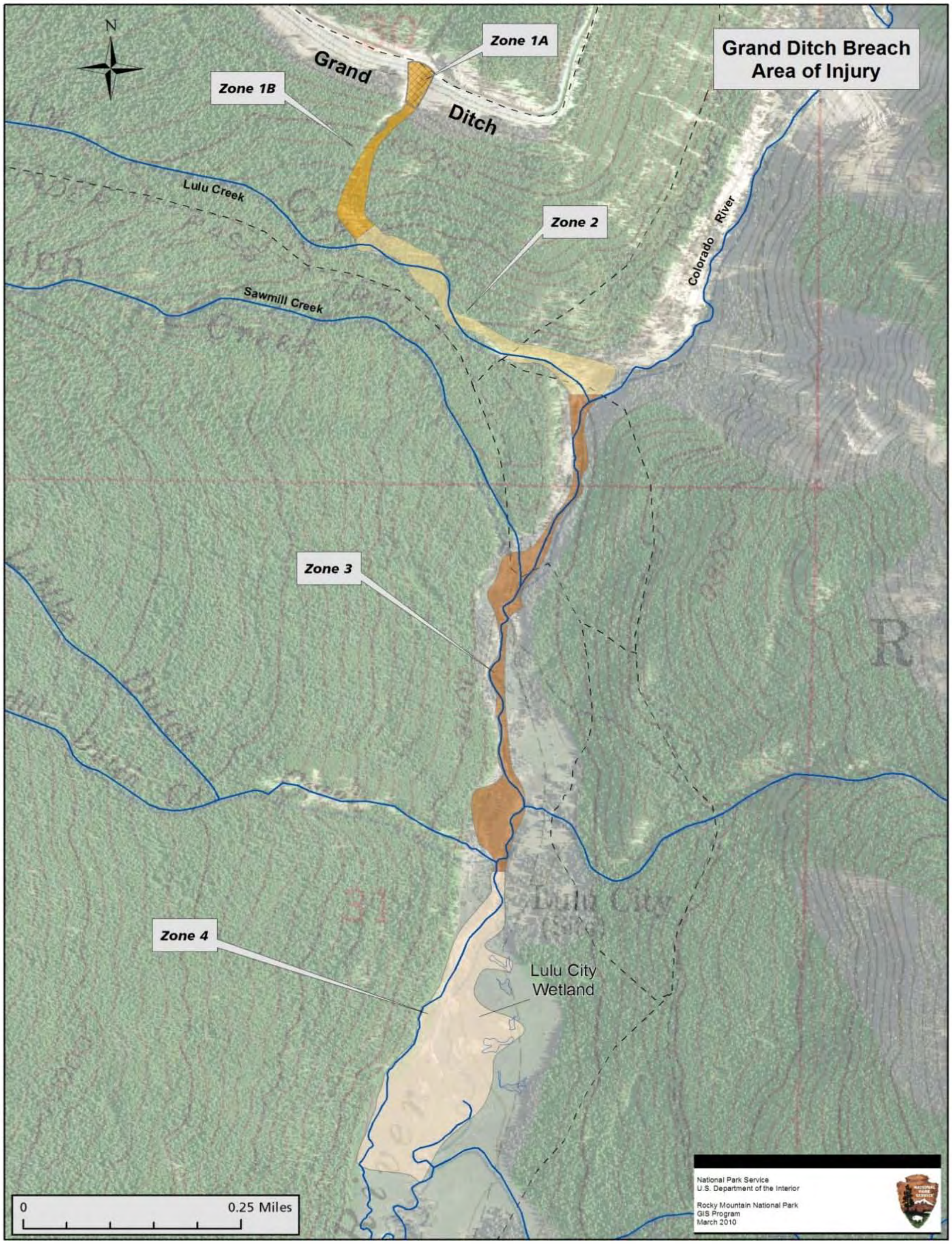

Figure 1.4: Zone Designations to be Addressed by the Restoration

Zone 3. This zone extends along the Colorado River from its confluence with Lulu Creek downstream to the head of the Lulu City wetland. Zone 3 suffered a substantial loss of subalpine fir and 16% loss of Engelmann spruce trees within the total area. A little over half of the shrub and herbaceous species in the injured area were lost. Sediment from zones 1 and 2 was deposited in this zone and continue to affect hydrologic conditions. Existing pools, riffles, and other in-stream aquatic habitat were either buried or substantially altered by debris deposits and transport downstream.

Zone 4. This zone extends from the north end of the Lulu City wetland south to its terminus. The Colorado River passes through this zone. Aerial photographs taken in 2001 allow for a baseline comparison to photographs taken in the summer of 2003 after the breach. Sediment deposition in zone 4 ranged from less than an inch to more than 3 feet thick. Thick sediment deposits occur where the Colorado River enters the wetland and along the western wetland edge, where the Colorado River has been confined for the past several decades as a result of debris flows from previous breach events. As a result, water discharges from the western channel along the margin of the fan as sheet flow that moves in a southeasterly direction through the wetland. Surface water movement through the wetland changes frequently in response to the import of additional debris during the annual spring snowmelt period. Some vegetation in the wetland was buried and killed. The sediment has raised the ground surface relative to the summer water table in some locations that received the most debris and sediment deposits. Other areas now experience high groundwater levels throughout the growing season (Cooper 2007).

The purpose of this project and the preferred alternative in the EIS would restore the vegetation and hydrological processes, ecological services, and wilderness character of the area in the Upper Kawuneeche Valley impacted by the 2003 Grand Ditch breach. In May 2008, the Water Supply and Storage Company, operators of the Grand Ditch, agreed to pay the National Park Service a settlement for restoration efforts in areas impacted by the 2003 breach. This agreement was reached under the Park System Resource Protection Act, 16 U.S.C. § 19jj (Civil Action No.: 06-cv-01728-REB-MJW). The National Park Service is solely responsible for the restoration activities.

Research conducted in the park indicates that landforms, hydrologic regime, and vegetation within the Lulu City wetlands have been highly impacted by the 2003 breach (Cooper 2006; 2007), and previous debris flows. The area of impact contains more sediment, debris, and subsequent damages from the Grand Ditch breach event than it would under natural conditions, affecting the ecological services of the area. One of the most prominent impacts is the alteration of the hydrologic regime and subsequent plant communities in the Lulu City wetland. Other impacts include impacts to aquatic, riparian and upland ecosystems, erosion, large deposits of debris, and lost vegetation.

The National Park Service is obligated by law and policy to maintain and restore, to the extent possible, the natural conditions and processes in park units (NPS 2006 Management Policies section 4.1.5). The area of impact along Lulu Creek and the Colorado River contains more sediment, debris, and subsequent damages from the Grand Ditch breach event than it would under natural conditions.

The following objectives for restoring the area impacted by the 2003 Grand Ditch breach were developed by the planning team and will be used as a measure of performance of the restoration alternatives.

- Restore appropriate stream and groundwater processes,
- Restore appropriate native plant communities,
- Restore the stability of the hillside below the breach site,
- Restore wilderness character,

- Restore wildlife habitat,
- Restore aquatic habitat, and
- Restore water quality in the affected area and downstream.

Restoration Actions by Zone

Under the NPS preferred alternative for the Grand Ditch Breach Restoration EIS, implementation of the restoration and conservation actions to minimize environmental impacts would be achieved in each of the zones as follows.

Zone 1A. Restoration options for zone 1A are necessarily engineered solutions required to stabilize the eroded road and ditch sideslopes and may not be consistent with the proposed alternative concepts that apply to the other zones in the project area.

The restoration objectives for zone 1A are to compact and stabilize the slope. To accomplish these objectives the following actions would take place:

- The slope would be smoothed by dragging a weighted chain, or similar device, over the slope face using a bulldozer at the slope crest. This would help to blend the over-steepened slopes on the lateral edges of the scar into the surrounding slope and remove unstable rocks on the slope surface, and reduce the erosion potential of sharp slope edges.
- The damaged area would be stabilized using soil-nail anchors that consist of long steel rods (about 8 feet long) that would be installed through the unconsolidated fill either by drilling or grouting, or by driving them directly into place. They would be installed through the fill starting from the slope crest and working in a downward direction.
- Steel mesh would be installed over the slope face and anchored to the soil nails. This would be done to prevent raveling of materials and would extend approximately 50 feet beyond the current limits of the scar.
- Specific surface treatments such as geocell installation, rock mulching, or gabions may be required in critical locations to control shallow, surficial flow slides and provide erosion protection for the recently-placed fill slopes.
- Installation of a reinforced earth cap along the ditch road would help maintain surface drainage away from the crest and reduce raveling of slope face materials. Installing the earth cap would consist of partially excavating the uppermost fill along the access road and replacing it with a compacted, geotextile, or geogrid reinforced earth section. Vertically-installed micropiles could be used to further stabilize loose-dumped fill beneath the reinforced-earth cap.

Mechanized equipment that would be used in the restoration activities include, but are not limited to, excavators, front end loaders, dump trucks, and water trucks. Some of this equipment would need to be specialized for use in very steep areas.

Equipment staging and stockpiling of materials before transport to zone 1A would be along the Grand Ditch service road in an area that has been previously disturbed, either graveled, cleared, or in a non-vegetated condition. Mechanized equipment would access the project area using the roadway. Restoration work would be conducted by contractors under the supervision of a NPS manager. The restoration work in Zone 1A would require two years to complete.

Zone 1B. In the majority of the zone 1B, exposed surfaces along the banks and in the gully would be revegetated through seeding with native grass seed. In areas where sufficient soil exist that would allow for propagation of seed, hand tools would be used to prepare the designated surfaces for receiving seed. Revegetation and spot stabilization would be done using small mechanized equipment such as small tillers; shovels and rakes; compactors; and hand tools to flatten banks and compact the disturbed soil. A walking excavator would be used to reshape and stabilize more difficult slopes.

Zone 2. Throughout zone 2, seeding of exposed surfaces that are conducive to seed propagation would take place in areas above the high water mark. Selected debris would be removed outside of the channel or re-oriented in the channel and along the banks using hand tools to stabilize banks and minimize erosion. Tree seedlings would be planted in the former alluvial fan and debris disposal area to stabilize the areas and to accelerate development of forest cover.

In zone 2, the stream banks are highly unstable in areas with debris deposits, making them susceptible to water erosion and downstream transport. Consequently, during peak runoff conditions the stream channel is moving laterally in this stretch of Lulu Creek. To reduce erosion, portions of the stream banks would be stabilized using appropriately sized cobble and boulders collected from within zone 2. Cobble and boulders would be repositioned to the toes of steep and unstable slopes to create an erosion-resistant foundation for bank retention.

In the area of the alluvial fan, Lulu Creek would be restored to reflect pre-breach conditions. The 2003 debris would be removed and a single stream channel with step pools would be established. Approximately 6,600 cubic yards of debris from the alluvial fan would be excavated to remove the primary source of constant debris erosion and permanently stored and stabilized in an existing debris-impacted area near the confluence of the creek and the river. The excavated debris would be used to create a terrace in a 0.4 acre upland area east of and well removed from the stream. The channel bed and banks would be protected from stream erosion with cobbles and boulders to prevent any lateral channel movement. The active channel would be wide enough to accommodate some lateral movement of the stream under a range of design conditions.

Revegetation and bank stabilization would be done using small mechanized equipment such as small tillers; shovels and rakes; compactors; and hand tools to flatten banks and compact the disturbed soil. Removal of the debris in the alluvial fan and recontouring of that area would require larger equipment such as steep slope/all terrain, walking excavators.

Zone 3. Debris removed during restoration activities would be deposited in an upland area in the vicinity of the Little Dutch Creek confluence with the Colorado River. This location has already been degraded by debris flows through the valley prior to 2003. The deposited debris would be contoured to reflect the surrounding topography and it would be planted with a grass seed mix and with tree seedlings to accelerate site stabilization.

Spot stabilization and revegetation throughout the zone would be done using mechanized equipment such as small tillers; shovels and rakes; compactors; and hand tools to flatten banks and compact the disturbed soil.

Areas outside of the active channel would be planted with spruce, lodgepole pine, fir, alders, and willows as dictated by site conditions. Approximately 2 acres within this zone would be revegetated. Over approximately 3 acres, upland species such as lodgepole pine and Engelmann spruce seedlings would be planted in the newly developed terrace area in the vicinity of Dutch Creek.

Zone 4. Under the preferred alternative, a channel would be excavated from a historic river meander at the northern end of the wetland of zone 4 to route the current river flow through the historic meander and into the historic central river channel. This meander would need to be excavated and the current river channel would need to be blocked, stabilized, and filled in to redirect river flow through the historic channel. Boulders and cobbles would be used to stabilize banks, create step pools, and to stabilize unstable sections of the riverbank along the relocated channel and restored section of meander.

To restore hydrologic conditions suitable to establish a tall willow complex, approximately 12,000 cubic yards of debris that resulted from the 2003 breach of the Grand Ditch would be removed from the wetland. Sediment removal would be accomplished with excavators operating on mats placed in the wetland during the lowest water period of the wetland.

The southern portion of the existing western river channel would be filled in with approximately 2,500 cubic yards of materials suitable to establish conditions for a tall willow complex and to minimize draining newly restored upstream or upgradient wetland areas.

Debris removed during restoration activities that was not used in the restoration of flow through the historic central channel would be deposited in an upland area in the vicinity of the same Little Dutch Creek confluence. Most of the recontouring and excavation work completed in this zone would be accomplished with large earth-moving equipment. Walking excavators, backhoes and front end loaders would be used to create the connecting channel, excavate debris from the wetlands and the historic channel, and to construct a berm or barrier to keep flow in the new center channel configuration. Temporary channels or by-pass pipes may be required to re-route Colorado River flows while work was underway to stabilize weak sections of the channel or to excavate the old river meander. Temporary turbidity and other water quality protection measures would require restoration and maintenance in zone 4 to minimize downstream water quality effects.

Within the treatment areas identified for zone 4, revegetation with cuttings and/or plugs of tall willow species would be conducted in graded and newly disturbed areas. Along the historic central river channel, the area would be revegetated with sedges. Approximately 8.5 acres of tall willows would be planted to create a tall willow complex under the preferred alternative.

Approximately 2,375 feet of fence would be used to protect newly planted willows from browsing pressure. Fences would remain in place until plants reached approximately 8 feet in height, at which point they would be able to withstand browsing pressure (assumed to last approximately 20 years) and the fence would then be removed.

SPECIES ACCOUNTS

Of the special status species shown in Table 1, only the Canada lynx and wolverine are considered for detailed evaluation in this biological assessment because the other species either are not present in the project area or have no potential to be affected. Species accounts for the lynx and wolverine are presented below.

The four listed fishes downstream in the Colorado River would not be affected by the proposed action because there would be no meaningful or significant change in downstream hydrology, water quality, or availability of water as a result of the proposed action. Although there would be small, localized water quality changes, these changes would not have any effect on the listed fish because of their distance downstream and the intervening lakes/reservoirs. The Mexican spotted owl and yellow-billed cuckoo are not found in the habitats that would be affected by the restoration project. The *Endangered Species Act (ESA) Endangered, Threatened, and Candidate Species List for Rocky Mountain National Park* indicates that the Mexican spotted owl is not known to occur in Grand

County and although the yellow-billed cuckoo was historically found in the park, it is no longer present (NPS 2011a).

CANADA LYNX

The Canada lynx, a federally listed threatened species and state-listed as endangered, was reintroduced into southwestern Colorado by the Colorado Division of Wildlife starting in 1999, with the purpose of establishing a viable population. During that first winter, the division had 19 records of four radio-collared lynx moving north from their release site and spending some time in or near the park between October 8, 1999 and April 28, 2000. Subsequent documented occurrences of lynx in the park include a confirmed sighting with a photograph in 2009.

Mature conifer forests are necessary for denning, and riparian areas are frequented during the summer. Primary areas of occurrence for lynx in Colorado are above 2,750 meters (9,022 feet) in elevation (McKelvey 1999). The lynx is a specialized carnivore that relies extensively on snowshoe hares (*Lepus americanus*), which provide up to 97% of their diet (Koehler and Aubry 1994). The park contains approximately 145,815 acres (54% of the park) of potential lynx habitat.

Human presence can have a large impact on lynx survival and behavior. For example, roads can be a primary source of mortality for lynx (USFWS 1997), and human activities, particularly in the winter, can cause lynx to avoid prime habitats (Oliff et al. 1999). However, repeated and consistent human disturbance will not necessarily preclude lynx from using an area, as they may adapt behaviorally or physiologically (Bowles 1995). The project area for this proposed action overlaps with potential lynx habitat in the park; therefore, any potential management activities associated with the proposed action may affect the Canada lynx.

Habitat Status

Critical habitat for the Canada lynx has been designated (USFWS 2009), but no critical habitat is designated in Colorado. Essential habitat and important habitat have not been defined for the Canada lynx. The Southern Rocky Mountain region has been proposed as a provisional core area in the development of the recovery plan.

Effects

Prior to initiating restoration activities in the project area each year, snow surveys looking for lynx tracks or sign would be performed to determine if lynx may be present. If lynx tracks or other sign are found, a more in-depth survey would be undertaken to determine if a den or breeding pair may be in the area. If a breeding pair is found, the NPS would not proceed further with any restoration activities. Consultation with the U.S. Fish and Wildlife Service would be initiated to determine a course of action that would not result in adverse effects to the lynx.

Ruediger et al. (2000) cite 17 risk factors with potential to adversely affect Canada lynx in terms of productivity, mortality, movement, or other large-scale risk factors. Of these, some elements of timber management, forest / backcountry roads and trails, and human development actions include actions that are similar to actions associated with the proposed action. The restoration would not include large-scale timber harvest, although the use of machinery and planting of trees are elements of timber management. Because of the limited nature and scope of these elements compared to full-scale timber operations, the risk to lynx would be negligible and unlikely. Temporary and very confined local construction roads would be used in the preferred alternative, however, the roads would be removed and habitat restored following completion of the project, unlike the long-term forest and backcountry roads that represent a risk to lynx. Again, the effects of the restoration projects roads on the lynx would be negligible. Lastly, the restoration project would include the use of machinery and have a human presence that would be similar to human development actions. However, the restoration actions would be short-term, mitigation measures would be implemented to minimize noise and habitat impacts, and no long-term developments would persist, unlike the actions that pose risks to the Canada lynx.

Increases in structural complexity and the areal extent of riparian habitat associated with restoration of riparian willow communities as a result of implementation of the proposed action would benefit Canada lynx that frequent riparian habitat in summer. The benefit would primarily be associated with increased foraging conditions and opportunities.

Noise disturbances could occur as a result of restoration activities. However, these disturbances would be offset and minimized as a result of mitigation measures, as management actions are unlikely to occur in high elevation areas during the spring denning season of lynx. Outside of sensitive periods, the restoration activities would occur for relatively short periods, and lynx could easily avoid the affected areas. Foraging lynx could be somewhat affected by occasional noise and human presence during summer/early fall (times without snowpack), however, this would represent only a minimal adverse effect.

Lynx movements would be unimpaired by fences used to protect plantings as the fences will be designed to only restrict access to newly planted shrubs and would not impair movement corridors. The effect would be inconsequential as lynx typically avoid areas with high degrees of human activity.

Cumulative Effects

In recent years, the use of low-flying commercial air tours over the park and the use of snowmobiles on Trail Ridge Road have been banned, which has resulted in a long-term, regional, beneficial effect on special status species. Wildlife vary in their responses to noise, but it can negatively affect many species, including lynx, through changes in behavior and physiological effects (USAF and USFWS 1988). However, minimal effects on lynx from noise disturbances from the proposed action would occur, as described above.

A number of actions in the park and on adjacent lands involve improving forest health, through controlling the pine bark beetle and managing forest fuels through mechanical thinning and prescribed fire. In particular, the *Fire Management Plan* for Rocky Mountain National Park, released in 2011, would maintain natural fire regimes to the greatest extent possible through a combination of manual fuels reduction, prescribed fire, and management of wildfires. By utilizing fire as a dynamic ecosystem process, this plan would help to maintain ecosystem structure, composition, and function and conserve biological diversity in the park (NPS 2011b). Activities related to the pine bark beetle and the fire management plan may temporarily affect the Canada lynx through temporary displacement and short-term alteration of habitat, a short-term adverse effect. However, in the long term, these actions would result in an overall long-term beneficial effect on Canada lynx, through improved habitat.

Management plans for protecting the park's natural resources would benefit the Canada lynx, through maintaining and restoring natural conditions and limiting intrusive activities. Restoring vegetative communities and removing exotic plants in the park would also enhance habitat, generally resulting in beneficial effects.

Activities outside the park also affect special status species within the park, as individuals outside can be within the same population as those within the park. Development on the west side of the park near Grand Lake, and in other areas outside of the park would continue to fragment and reduce habitat that could be used by the Canada lynx. On a regional scale, this would represent a long-term adverse effect on Canada lynx, through direct loss and fragmentation of habitat. The proposed action would not contribute to this long-term adverse effect.

Conclusion and Determination of Effect

The minimal short-term adverse effects to Canada lynx from noise disturbance and human presence during late summer and early fall would combine with the long-term beneficial effect associated with restoration of willow and forest habitats to result in an overall long-term beneficial effect to Canada lynx. Thus, the determination of effect from the Grand Ditch breach restoration on the Canada lynx would be "*may affect, not likely to adversely affect*."

WOLVERINE

The wolverine was recently designated as a candidate species for endangered species protection (USFWS 2010) and is listed as endangered by the state of Colorado. The wolverine's presence in Rocky Mountain National Park had not been confirmed until 2009, when a wolverine was sighted within the park boundary. The last reported location of the wolverine, in February 2011, was in the Never Summer Range along the northwestern boundary of the park (NPS 2011c). Scientists estimate that 250 to 300 wolverines currently inhabit the contiguous United States (USFWS 2010).

The wolverine does not appear to specialize on specific vegetation or geological habitat aspects, but instead selects areas that are cold and receive enough winter precipitation to reliably maintain deep persistent snow late into the warm season (USFWS 2010). The requirement of cold, snowy conditions means that, in the southern portion of the species' range, including Rocky Mountain National Park, where ambient temperatures are warmest, wolverine distribution is restricted to high elevations. Female wolverines use natal (birthing) dens that are excavated in snow. Persistent, stable snow greater than 5 feet deep appears to be a requirement for natal denning. Natal dens consist of tunnels that contain well-used runways and bed sites and may naturally incorporate shrubs, rocks, and downed logs as part of their structure. Offspring are born from mid-February through March, and the dens are typically used through late April or early May (USFWS 2010).

The wolverine is very susceptible to human activities and may abandon its den site in response to such minor disturbances as cross-country skiers (NPS 2007). Though it is unlikely that there are any den sites in the project area, any disturbance from restoration activities could impact foraging habitats of the wolverine. Wolverines are opportunistic feeders and consume a variety of foods depending on availability. They primarily scavenge carrion, but also prey on small animals and birds, and eat fruits, berries, and insects. Wolverines require a lot of space; the availability and distribution of food is likely the primary factor in determining wolverine movements and home range size (USFWS 2010). Home ranges may range from less than 40 to over 340 square miles and daily normal foraging movements can range from 18 to 25 miles (Banci 1994). As a result, wolverine population density can be categorized as very low, particularly in the periphery of its range, which includes Rocky Mountain National Park. The project area may contain potential habitat for the wolverine and any management activities that alter foraging habits could potentially affect the species. The project area is also regularly affected by the daily maintenance activities of Grand Ditch inspection and maintenance crews that service the ditch and its diversions structures. These activities introduce human presence and disturbances into the project area.

Habitat Status

Because the wolverine is a candidate for listing, no critical habitat has been designated.

Effects

Prior to initiating restoration activities in the project area each year, snow surveys looking for wolverine tracks or sign would be performed to determine if wolverine may be present. If wolverine tracks or other sign are found, a more in-depth survey would be undertaken to determine if a den or breeding pair may be in the area. If a breeding pair is found, the NPS would not proceed further with any restoration activities. Consultation with the U.S. Fish and Wildlife Service would be initiated to determine a course of action that would not result in adverse effects to the wolverine.

The noise, mechanical disturbance, and human presence associated with restoration activities do have the potential to affect the wolverine. However, the limited seasonal duration of restoration activities, the relatively small project area compared to the home range and foraging areas of a wolverine, and the very low density of wolverines in the southern Rocky Mountains, including the park, make the potential for effect low. It is not likely that wolverines are resident near the project. Any wolverine that would be within the range of effects from the Grand Ditch breach restoration project would likely be transient and be able to detect the presence of humans and mechanized equipment well before any adverse effect could occur. The potential effect of such an encounter would be that the wolverine would avoid the project area and the disturbance effect would be short or temporary. While avoidance could be viewed as a disturbance, the low potential for a transient, casual wolverine to be affected by the project would be unlikely and as such, inconsequential.

Similar to the effects described for the Canada lynx, the wolverine would not be affected by the installation of fences to protect plantings. The fences would not impair any wolverine movement corridors. The effect would be inconsequential as wolverine typically avoid areas with high degrees of human activity.

Similar to the effects described for the Canada lynx, restoration of the plant communities and habitat in the area affected by the Grand Ditch breach would result in beneficial effects for all wildlife species, including the wolverine.

Cumulative Effects

The threat with the greatest potential to adversely affect the wolverine is climate change. Increased spring and summer temperatures and a reduced incidence of persistent spring (April and May) snowpack could result in a loss of suitable denning habitat if warmer climate predictions are correct. According to analyses completed by the University of Washington's Climate Impacts Group and the USDA Forest Service's Rocky Mountain Research Station, wolverine habitat in the contiguous United States is likely to decrease in aerial extent by 23% by 2045 and 63% by 2099 (USFWS 2010). With lower elevation habits becoming unsuitable and other habitat being affected by numerous other human activities and land use changes, remaining wolverine habitat is likely to become more fragmented. Connectivity between remaining wolverine habitats will be reduced, increasing rates of loss of genetic diversity and making the retention of small populations more difficult. Climate change could have synergistic effects when combined with other threats to the wolverine resulting in exacerbated adverse impacts (USFWS 2010).

Other potential cumulative actions include increased backcountry recreation, especially during the denning season, as a mother wolverine may tend to move its kits to alternate denning areas if humans have been detected nearby. Recreational activities such as snowmobiling and backcountry skiing may have the potential to affect the wolverine however this has not been documented by research at this time. Further research is needed to confirm whether these activities have measurable impacts on the species (USFWS 2010).

The *Fire Management Plan* for Rocky Mountain National Park, released in 2011, would have long-term beneficial impacts to the wolverine. The plan would maintain natural fire regimes to the greatest extent possible through a combination of manual fuels reduction, prescribed fire and management of wildfires. By utilizing fire as a dynamic ecosystem process, this plan would help to maintain ecosystem structure, composition, and function and conserve biological diversity in the park (NPS 2011b). While activities related to the fire management plan may adversely affect the wolverine through temporary displacement and short-term alteration of habitat, a short-term adverse effect, these actions would result in an overall long-term beneficial effect on wolverine by improving habitat conditions.

Considering the small size of the wolverine population in the lower 48 states, only 1 documented sighting in the Rocky Mountain National Park area in decades, these potential adverse cumulative effects would be negligible to minor.

Conclusion and Determination of Effect

The extremely low likelihood that a wolverine would be affected by the noise, mechanical disturbance, and human presence associated with restoration activities, combined with the long-term beneficial effects represented by the restoration of the plant community and habitat in the project area, would result in an overall long-term beneficial effect on the wolverine. Thus, the determination of effect from the Grand Ditch breach restoration on the wolverine would be "*may affect, not likely to adversely affect*."

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LIST OF CONTACTS/CONTRIBUTORS/PREPARERS

Individual	Organization	Role
Mary Kay Watry	NPS, ROMO	Provided biological information
John Mack	NPS, ROMO	Provided biological information
Don Kellett	Parsons	Prepared biological assessment
Aaron Sidder	Parsons	Prepared biological assessment
Bruce Snyder	Parsons	Prepared biological assessment

APPENDIX A
ENDANGERED SPECIES ACT (ESA)
ENDANGERED, THREATENED, AND CANDIDATE SPECIES LIST FOR ROCKY MOUNTAIN NATIONAL PARK

Endangered Species Act (ESA)

Endangered, Threatened, and Candidate Species List

for

Rocky Mountain National Park

Current as of April 7, 2011

The following table contains a list of species that are specific to Rocky Mountain National Park (RMNP) and are federally listed as endangered, threatened or candidates for listing by the U.S. Fish and Wildlife Service (USFWS) under the provisions of the Endangered Species Act (ESA).

The species that are included in the table must meet one of the following criteria:

1. The species is known to occur within the park.
2. The species does not occur within the park, but suitable habitat is available, the habitat is within the known elevation range for the species, and the species is known to exist in counties that the park occupies.
3. The species does not occur within the park, but actions within the park have the potential to affect the species.

In compliance with the ESA, all management actions within the park are evaluated to determine if they will have any effect on the species on this list.

Federally Listed and Candidate Species & Their Status in Colorado	Known to Occur in RMNP	Known to Occur in Boulder County	Known to Occur in Larimer County	Known to Occur in Grand County
Birds				
Least tern (interior population) *Sternula antillarum* Endangered	No ▲	▲	▲	No
Mexican spotted owl *Strix occidentalis lucida* Threatened	No	Yes Historically	Yes Historically	No
Piping plover *Charadrius melodus* Threatened	No ▲	▲	▲	No
Whooping crane *Grus Americana* Endangered	No ▲	▲	▲	No
Yellow-billed cuckoo *Coccyzus americanus* Candidate for Listing	Yes Historically	No	No	Yes
Fish				
Bonytail *Gila elegans* (presumed-historical) Endangered	No *	No	No	*
Colorado pikeminnow *Ptychocheilus lucius* Endangered	No *	No	No	*

Federally Listed and Candidate Species & Their Status in Colorado	Known to Occur in RMNP	Known to Occur in Boulder County	Known to Occur in Larimer County	Known to Occur in Grand County
Greenback cutthroat trout *Oncorhynchus clarki stomias* Threatened	Yes @	Yes	Yes	No
Humpback chub *Gila cypha* Endangered	No *	No	No	*
Pallid sturgeon *Scaphirhunchus albus* Endangered	No ▲	▲	▲	No
Razorback sucker *Xyrauchen texanus* Endangered	No *	No	No	*
Mammals				
Canada lynx *Lynx canadensis* Threatened	Yes	Yes	Yes	Yes
Preble's meadow jumping mouse *Zapus hudsonius preblei* Threatened	No ▲	Yes	Yes ©	No
Wolverine *Gulo gulo luscus* Candidate for Listing	Yes	No	No	No
Plants				
Colorado butterfly plant *Gaura neomexicana* spp. *Coloradensis* Threatened	No ▲	Yes ▲	Yes ▲	No
Ute ladies'-tresses orchid *Spiranthes diluvialis* Threatened	No ▲	Yes ▲	Yes ▲	No

Table Terminology:

*	Water depletions in the Upper Colorado River basin may affect these species and/or habitat in downstream reaches.
▲	Water depletions in the South Platte River basin may affect these species and/or habitat in downstream reaches.
©	There is designated critical habitat for the species within the county.
Candidate	Means there is sufficient information indicating that formal listing under the ESA may be appropriate.
Endangered	Means the species could become extinct.
Threatened	Means the species could become endangered.
@	Due to recent genetic studies that are evaluating the greenback cutthroat trout and the Colorado River cutthroat trout, section 7 consultations will need to occur *for the interim* on select western slope streams containing cutthroat populations that appear to be greenback cutthroat trout, as based on genetic information. The FWS will provide a list of western slope streams selected for consultation; this list will be recommended by the Greenback Cutthroat Trout Recovery Team. Consultation on greenback cutthroat trout streams on the western slope is intended to be a temporary measure that provides protection of potential greenback cutthroat trout genetic material until this issue has been resolved.

APPENDIX C: COMMENTS AND RESPONSES ON DRAFT ENVIRONMENTAL IMPACT STATEMENT

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INTRODUCTION

A notice of availability for the draft environmental impact statement for the Grand Ditch breach restoration was published in the *Federal Register* and the draft environmental impact statement was made available for public comment on March 16, 2012. A 60-day public comment period was opened for the draft environmental impact statement that extended to May 25, 2012.

The NPS received a total of 10 response documents in addition to oral comments received at the public meetings. The documents submitted contained multiple individual comments or suggestions regarding the Grand Ditch breach restoration project. Based on the review of all public input, a total of 47 substantive comments were received on the draft environmental impact statement.

- Many of the public responses (36 percent) were in regards to the alternatives. They expressed support of, or opposition to, specific alternatives, as well as additional suggestions.
- The largest amount of comment was submitted by two members of the public. Their scoping comments focused on the analysis of the no action alternative, the characterization of the baseline conditions, and the rationale for restoration actions proposed in the NPS preferred alternative, alternative D.
- Other responses ranged from general questions, to expressing concerns about construction methods, historic debris flows, the settlement, and the purpose of the restoration project.
- Many comments were directed at the analysis of the no action alternative.
- Most of the public written comments were generally supportive of restoration to the impacted area. Public attendees and written responders questioned the cost of restoration methods and the impacts that may result. Concerns regarding impacts to fisheries were included in a letter from Colorado Trout Unlimited (CTU).
- Comments covered a broad range of topics with comments regarding restoration projects in zones 3 and 4 under alternative D receiving the single largest number of comments (11 comments). Many of these comments were in a letter from the Water Supply and Storage Company (WSSC) who owns and operates the Grand Ditch.

At the close of the comment period, the National Park Service analyzed the content of public and agency responses. Every response was divided into its individual comments, each of which received a unique number. Each comment was then categorized in terms of its subject matter and content and assigned one or more codes to identify the topics it addressed. These topics include alternatives, the Grand Ditch breach, construction methods, costs, impacts and analysis, purpose and need, and rules and regulations. The comments were summarized into 25 concern statements.

After all comments were coded, similar comments were grouped as "concern statements." Each concern statement was evaluated to determine whether it was substantive or non-substantive, according to the criteria in section 4.6.A of *Director's Order #12 and Handbook* (NPS 2001a), which are based on the Council on Environmental Quality (1978) regulations for implementing the National Environmental Policy Act.

Substantive comments are defined as those that do one or more of the following:

- Question, with reasonable basis, the accuracy of information in the environmental impact statement;
- Question, with reasonable basis, the adequacy of environmental analysis;
- Present reasonable alternatives other than those presented in the environmental impact statement; or
- Cause changes or revisions in the proposal.

In other words, they raise, debate, or question a point of fact or policy.

Comments in favor of or against the proposed action or alternative, or comments that only agreed or disagreed with NPS policy, were not considered substantive.

A response was provided for each of the issues that were considered substantive. Typically, the response identified where the information was already available in the environmental impact statement, described how the final environmental impact statement was changed, or explained why the final document was not changed. Non-substantive comments did not receive a response.

There often were multiple comments that addressed the same issue. In these cases, one or more comments that effectively expressed the issue were selected as representative of the issue and are included in this appendix. Comments are mostly verbatim, but minor editing was provided to correct spelling or grammar, improve clarity, or reduce length.

The comment and response section is followed by reprinted copies of the responses received from public agencies.

CONCERN STATEMENTS AND RESPONSES

The following presents the concerns raised during the public review period arranged by concern statement along with a representative sample of supporting quotes. Each concern statement is followed by an NPS response.

ALTERNATIVES

Concern Statement 1: It appears that NPS does not consider the no action alternative (NAA) as a viable selection option.

Comment: *"P. 43 "After the National Park Service has selected a final alternative?" Makes it sound like the NAA has no chance for selection (which, in reality it probably doesn't but has to at least appear as a viable option). It is noted that this and other similar statements in the DEIS give the impression NPS is not considering the NAA as a viable selection option." Correspondence #05*

Response: The no action alternative continues current management of the project area with no active response to restore the damage done by the 2003 breach. The no action alternative is inconsistent with the settlement between the Water Supply and Storage Company and the United States. Additionally, this alternative does not meet the stated purpose and objectives of the plan nor does it resolve the need for the project. As discussed in CEQ and DO-12, although the no action alternative may not be considered reasonable, it is presented to serve as the baseline condition by which to evaluate the impacts of the other reasonable alternatives.

Concern Statement 2: None of the action alternatives would provide the minimum required restoration.

Comment: *"If none of the action alternatives would provide the minimum required restoration, please provide a new alternative that would provide the minimum restoration, including estimated costs." Correspondence #05*

Response: There is no minimum required level of restoration prescribed by the Park System Resource Protection Act (PSRPA) for any resource injury. PSRPA does not require NPS to restore resources or to return resources to pre injury conditions. The only requirement PSRPA places on NPS is that if NPS chooses to use the damages received through a settlement or awarded by a court, those damages must be used to reimburse past costs or to restore, replace or acquire the equivalent of the resource injured.

The settlement, on the other hand, does state NPS's intent to stabilize Zone 1A and in doing so requires cooperation with WSSC in the planning for the stabilization. All of the proposed action alternatives meet this requirement. For the remaining Zones of the project, no restoration requirements are described in the settlement.

The proposed action alternatives, except for the NAA, provide for varying levels of active restoration that move the resource conditions on slower or faster trajectories to recovering ecological services lost.

Concern Statement 3: Option 1 in zone 1A will not provide long-term stabilization for the Grand Ditch.

<u>Comment:</u> "In any event, if the NPS proceeds with option I, it must recognize and assume responsibility for the residual impairment to the Grand River Ditch and the attendant risk of another breach of the Ditch. The DEIS has not adequate or reasonably explained why it the preferred alternative would not include placement of fill material in the slope area below the breach location. WSSC will not bear further responsibility or liability for a breach of the Grand River Ditch in this location if the NPS proceeds with option 2." Correspondence #07

<u>Response:</u> The NPS carefully evaluated both option 1 and 2 for the stabilization for zone 1A. The NPS believes that option 1 will provide long-term stabilization to the slope in zone 1A utilizing only the tie back anchor and soil nail system. In 2007, a report by Telesto Solutions, Inc., an independent engineering firm, determined that option 1 was appropriate to provide long-term stability for zone 1A. A 2009 re-evaluation of this recommendation by the same company was completed to take into account the apparent tension cracks that had formed near the edges of the scar and to compare the recommendation to WSSC's June 2008 proposal to restore zone 1A to a pre-breach topography (option 2). The 2009 report affirmed that the 2007 recommendation of option 1 was still appropriate to stabilize zone 1A.

Concern Statement 4: Option 2 for zone 1A will return the stability of the ditch bank back to, or greater than, its original condition.

<u>Comment:</u> "WSSC believes that option 2 should be the preferred alternative. With correct engineering and construction techniques, this option will return the stability of the ditch bank back to, or greater than, its original condition and, with correct fill material and vegetative restoration, will minimize surface erosion in the area below the location of the breach." Correspondence #07

<u>Response:</u> Both options 1 and 2 for the stabilization for zone 1A are viable and have been considered. However, the NPS has concluded that option 1 will adequately stabilize the slope in zone 1A without the need to place fill material in the breach scar based upon reasons articulated on page 76 of the DEIS: "In zone 1A, option 1 to stabilize existing slopes, using a tie-back anchoring system was determined to be the most effective alternative because it would meet objectives to stabilize the breach scar and would:

- contribute smaller impacts on the untrammeled quality of the adjacent wilderness because soil nails in existing slopes would involve less human manipulation;
- provide increased immediate and long-term stability within the scar with less concern for compaction or sloughing of large amounts of fill material; and
- result in less impact on park resources from implementation and the amounts of mechanized equipment activity.

The above points are consistent with the conclusions drawn by Telesto Solution Inc., an independent engineering firm, in their 2007 expert opinion report and their 2009 report, Reevaluation of

Grand Ditch Stabilization Alternatives for zone 1A of Breach. NPS has concluded that option 1 is an effective, appropriate, and sufficient solution to the stabilization of zone 1A.

Concern Statement 5: Plans to mitigate impacts to trout are insufficiently presented in the DEIS.

Comment: *"Unless the mitigation plan for re-routing the Colorado River in zone 4 includes other means of safely re-locating trout from the channel to be abandoned, a similar rescue in the Lulu wetlands is likely to be needed. However, the logistics of getting people and equipment into the Lulu site are considerably more difficult than at Roaring River. So advance planning and notice of the timing of the water diversion will be essential. The DEIS (page 68) seems overly simplistic about the need for such planning when it says, "Instream flows would be maintained throughout the entire channel construction, diversion, and restoration operations."" Correspondence #06*

Response: The FEIS will be revised to address the supplemental trout sampling information that was provided by the USFWS for the years 1999 to 2010. The affected environment conditions will be updated to reflect this information. The impact analyses of the alternatives will be revised to specifically address trout habitat and trout population implications of implementing the alternatives.

Mitigation measures to avoid and minimize effects to trout will be added or edited to address the points raised by the comments. For example, a measure will be added to specifically state that trout will be captured from stream segments prior to construction activities and they will be released into other unaffected stream segments. It will also be noted that some of the listed water quality protection and mitigation measures (e.g., controlling turbidity and suspended sediments) also mitigate potential trout impacts. Additionally, it will be noted that modified and new mitigation measures will be identified as the project moves into detailed design and as more information becomes available about the nature of the trout resources and the hydrology in the Colorado River and the Lulu City wetland.

Concern Statement 6: The preferred alternative should address mitigating damages to sites of cultural significance and importance.

Comment: *"My final concern is that because the Grand Ditch is on the National Register and because there are known traditional cultural properties associated with the North Inlet trail, the relief group should make sure to consider this. While also restoring instability of the Ditch, whichever group is in charge should also seek to spend part of the budget mitigating damaged sights of cultural significance and importance." Correspondence #01*

Response: The DEIS identifies mitigating measures for cultural resources in the "Alternatives" chapter of the text. The damaged area within the park was surveyed by archeologists following the breach event. The reports concluded that no known archeological or historic structures within the park were impacted by the breach event. With implementation of mitigation measures, the EIS concludes there will be no adverse effects to cultural resources within the project area. The Colorado SHPO has concurred with these findings.

The Grand Ditch is not within NPS jurisdiction and the NPS is not responsible for its management or maintenance. The portion of the ditch that breached was repaired by the owners of the ditch. The breach and subsequent repairs may have impacted the National Register of Historic Places eligibility of that particular segment of the Grand Ditch.

Concern Statement 7: The restoration projects described in alternative D for zones 3 and 4 are not necessary as a result of the 2003 breach or to comply with the Park System Resource Protection Act.

Comment: *The Draft Environmental Impact Statement is inaccurate and misleading to the public. The primary restoration projects described in the preferred restoration alternative (Alternative D) for zones*

3 and 4 are not necessary as a result of the 2003 breach, nor do they restore natural resources impacted by the 2003 breach. Most of zones 3 and 4 have already recovered in their entirety and ecological services have been restored." Correspondence #07.

Response:

The Park System Resource Protection Act (PSRPA) authorizes the Secretary of the Interior to recover damages not only for the costs to restore, replace or acquire the equivalent of injured resources, but also for the loss of use (i.e., services) of an injured park system resource pending restoration. Under PSRPA (16 USC 19jj), "damages" includes compensation for "*the value of any significant loss of use of a park system resource pending its restoration or replacement or the acquisition of an equivalent resource*." These interim losses of natural resources and/or services pending recovery are intended to be restored by way of compensatory restoration projects. PSRPA does not make requirements on how an injured resource is restored to baseline conditions or how services lost are compensated. The NPS has full discretion based on NPS Policy, scientific information and public input to decide how best to restore the resources injured. As such, compensatory restoration projects can be off-site (i.e., outside the footprint of the original injury) or, in some cases, on-site (i.e., within the footprint of the original injury). On-site compensatory restoration typically takes a particular resource back to a historic condition that a park has determined is ecologically better than the condition the resource may have been in just prior to the injury. The credit gained for restoring services from the pre-injury baseline to the "better historic condition" is considered compensation for services lost to that resource from the original injury.

Concern Statement 8: The actions in zone 3 will be ineffective over time.

Comment: "Conditions in zone 3 are the result of a normal hydrologic progression occurring over many years and resulting from numerous natural sediment deposition events prior to the 2003 breach. The sediment berms and other stream channel characteristics that currently exist in zone 3 will likely re-form and will negate any purported benefit of the preferred restoration alternative." Correspondence #07

Response: The channel modifications in most of zone 3 are minimal, except in the upstream section of the zone near the river's confluence with Lulu Creek. Restoration actions in the upstream portion of Zone 3 are expected to be effective over time and will benefit the downstream section of the zone by the removal of large sediment deposits. The dynamic nature of the river channel, riverbed, and streambanks in zone 3 is recognized, especially during peak flow conditions, and could result in the reforming of sediment berms in the downstream section.

THE GRAND DITCH BREACH

Concern Statement 9: The DEIS does not address efforts to reduce or eliminate future breaches.

Comment: "P.4 The cause of the 2003 breach is uncertain. Due to the substantial damage that resulted from this and previous breaches, please describe efforts by the NPS and ditch owners to monitor the ditch to reduce or eliminate future breaches." Correspondence #05

Response: The Grand Ditch is privately owned and operated. Therefore, activities related to management of the ditch are beyond the jurisdiction of the NPS and the scope of this EIS.

Concern Statement 10: The DEIS does not consistently present the percentage loss of ecological services for all zones.

Comment: "P. 8 The DEIS indicates that zones 1 and 2 had 100% and 89% loss of ecological services, respectively. Please also provide the loss of ecological services that occurred in zones 3 and 4." Correspondence #05

Response: Upon further analyses of the relevant documents, we have found percent of ecological services lost that had been originally calculated for all zones. Text changes to the DEIS will be made to incorporate this new information (see page 11 of FEIS).

CONSTRUCTION METHODS

Concern Statement 11: The use of mechanized equipment will cause excessive damage to resources.

Comment: *"The use of large excavation equipment in zone 4 will cause extensive harm because of the need to construct roads for the equipment, the disruption and destruction of vegetation resources and disturbance of hydrologic resources including stream channels. The anthropogenic impacts to Area N discussed above under zone 3 also apply to zone 4." Correspondence #07*

Response: The EIS considers the tradeoffs between the continuation of current conditions (no action) which would require no mechanized equipment and the action alternatives that would include increasing amounts of short-term restoration activity involving varying amounts of short-term mechanized equipment use. The EIS analyzes the degree of restoration and the timeframe within which ecological reference conditions would be achieved and has determined that the long-term benefits of more complete restoration are greater than the short-term adverse impacts that would result from mechanized equipment. The short-term impacts would be mitigated through a variety of actions as noted in the EIS. The NPS has determined that no unacceptable impacts would result from the use of mechanized equipment under the preferred alternative.

Concern Statement 12: The use of heavy equipment may cause instability to the Grand Ditch.

Comment: *"The debris, unless it is blocking important river flow or animal habitat, should not be moved by heavy equipment that could perpetuate the instability of the Ditch." Correspondence #01*

Response: Work in the vicinity of the Grand Ditch is required for stabilization of the slope and necessitates the use of heavy equipment. The operation of heavy equipment in the proximity of the Grand Ditch will employ best practices to ensure the stability of the ditch is maintained.

COSTS

Concern Statement 13: The costs of the alternatives should be presented as a range including the amount of error in the estimates.

Comment: *"P. 27 Rather than stating the cost of the preferred alternative it may be more appropriate to show the range of cost estimates for action alternatives ($5 M to $18 M). In addition, it may be appropriate to indicate that the estimates could be off by as much as -30 to + 50%." Correspondence #05*

Response: The text has been changed to present the basis of the cost estimate. The costs were developed based on the approximate 15% preliminary design. This level of design presents a schematic framework that is based on estimated project dimensions and parameters that will be refined in the next step of design. The next step of design will precisely define all project quantities that will be necessary to achieve the project objectives such as the exact areas, depths, and volumes of debris to be excavated and moved. The range of error in the current cost estimates could be as high as +/-50% in some locations within the project area and as low +/- 10% in other locations.

IMPACTS AND ANALYSIS

Concern Statement 14: Additional actions should be included in the cumulative scenario.

Comment: *"P.5 As required by NEPA, please discuss these other restoration actions [actions taken outside of the park to mitigate damages resulting from the breach] as part of the cumulative impacts analysis for the proposed project." Correspondence #05*

Response: To the NPS' knowledge there are no other restoration actions being taken outside the park as a result of the breach. Restoration plans and other plans described in the "Planning Documents for Rocky Mountain National Park" in the "Purpose of and Need for Action" chapter as well as the list of other future actions listed in the "Cumulative Effects Analysis Method" in the "Environmental Consequences" chapter were considered in the evaluation of cumulative impacts.

Concern Statement 15: The alternatives should be analyzed in a 20-year timeframe and not just after active restoration actions take place.

Comment: *"Although Alternative E may require heavy equipment and helicopters in the early stages of the project, the wilderness character will be resumed more quickly. This project should be analyzed in a 20 year plus timeframe and the natural resources services provided at the end of those 20 years or earlier and not on the few years where active restoration will take place." Correspondence #02)*

Response: As stated in the "General Methodology for Establishing Impact Thresholds and Measuring Effects by Resource" section of the "Environmental Consequences' chapter, the analysis period has a wide range as some impacts only occur while restoration activities are occurring, and others such as restoring late successional forests can take hundreds of years. Each resource topic has been analyzed as to the short-term and long-term impacts of restoration activities with a definition of long-term provided for each resource. In general long-term impacts are those that would occur after restoration activities have taken place and extend beyond a 20-year timeframe. As depicted in the conceptual model on page 41 of the DEIS, we recognize that the ecological services provided by the 5 alternatives will differ between the stated restoration goals achieved at the 20 year point.

Concern Statement 16: The characterization and analysis of fish populations is too limited and should be expanded.

Comment: *"With respect to fisheries biology, CTU believes the DEIS has only minimally addressed two critical issues, namely: (1) near-term impacts on existing trout populations now inhabiting and downstream of restoration zone 4, and (2) long-term habitat needs of cutthroat trout in the Colorado River. It also fails to use existing available data from fish surveys conducted on behalf of RMNP." Correspondence #06*

Response: The FEIS will characterize the existing fish populations in the upper Colorado River near the project site and in Lulu City wetland using the fish survey information from the USFWS in these areas. Impacts to the trout populations and habitat from construction of the alternatives (including potential downstream effects) will be updated based on this information and on the mitigation measures that could be employed to avoid and minimize potential construction effects. Once the channel and wetland restoration designs and engineering have advanced to more detailed levels, a mitigation plan to address trout, aquatic life, wetland, and hydrologic values and functions will be prepared based on a better understanding of the specific physical changes that are planned. The FEIS discussion of mitigation measures will be revised to also note that measures used to protect water quality also protect trout and other aquatic life.

Trout will be captured and relocated from the proposed restoration areas in zones 3 and 4 to other stream areas before restoration begins. Stream and wetland habitats will be designed to accommodate trout use. It is anticipated that trout will recolonize the restored areas after channel and wetland construction activities are completed.

Concern Statement 17: The trout population in the project area should be surveyed prior to the start of restoration activities.

Comment: *"Although we do not have specific results of those surveys, TU volunteers were able to observe that there is a large population of trout in the Lulu City wetlands, perhaps more than a thousand in the reach of the Colorado River that is to be re-located. Presumably the specific data from these population surveys is available in the records maintained by Rocky Mountain National Park, and we recommend such data be examined to assist in determining mitigation actions that would be desirable during the habitat restoration work." Correspondence #06*

Response: The NPS will rely upon the findings of the USFWS trout surveys of the Lulu City trend site or Lulu City wetland if the survey(s) are completed just before restoration activities are scheduled to start. Coupled with the commitment to salvage existing trout from the proposed construction areas and relocate them to unaffected stream reaches, this approach should minimize adverse effects to the existing trout population in the work locations.

Concern Statement 18: Additional analysis of the effect of silting and Colorado River hydraulics is needed.

Comment: *"The silting of The Upper Colorado needs to be dealt with. Consistent lower water flows require some help with the shape of the river bottom. I'm less interested in historical river structure compliance, and more interested in a functioning river during lower flows. The silt and aggregates that come down the North Fork into Shadow Mountain Reservoir are also unacceptable. These particulates end up all over the CBT and Three Lakes due to water transport." Correspondence #03*

Response: This concern was identified during the evaluation and scoping processes, and was a main reason for Grand County's participation as a cooperating agency during the preparation of the DEIS. The proposed suite of water quality and aquatic life mitigation measures include several measures specifically intended to retain and minimize downstream transport and generation of water turbidity and suspended solids at the restoration sites. Additionally, the DEIS analysis of potential downstream turbidity and suspended sediment effects to downstream locations was addressed in the water quality section. The analysis suggested that potential transport of these materials into Shadow Mountain Lake from restoration activities was an unlikely to minimal impact based on distances from the restoration area to the lakes, limited water quality samples, field observations, and aerial photo evaluations.

Concern Statement 19: A comprehensive plan to restore tree and plant populations in the damaged area is needed.

Comment: *"In light of the huge scar that was scraped on the face of Rocky Mountain National Park and all of the trees that were uprooted within Lulu Creek there should also be a comprehensive plan to restore the local tree and plant populations of the Park area." Correspondence #01*

Response: When the detailed designs for restoration are prepared in the next phase of the project, a detailed vegetation plan will be included that will identify the types, quantities, and densities of species to be seeded or planted in the project area.

Concern Statement 20: The DEIS does not adequately explain the geographic scope of the EIS.

Comment: *"P.5 The DEIS indicates damage from the breach occurred as far away as 27 miles downstream. However it appears the scope of the DEIS is restricted to damages that occurred in the Park. Please specify the geographic location of the proposed project." Correspondence #05*

Response: The geographic area evaluated for impacts of the proposed alternatives in general includes the area directly affected by the breach and areas adjacent to the restoration area as stated in the "Geographic Extent of Impact" section in the "Environmental Consequences" chapter. In addition, each resource impact methodology includes a more specific description of the geographic extent.

Concern Statement 21: Concerns were expressed regarding the methodology and analysis of the no action alternative.

Comment: *"As discussed above, the impacts of the NAA appear to be assessed with a different methodology then the impacts of the action alternatives. The result is what appears to be an 'apples to oranges' comparison of impacts, as evidenced by the fact that Alt B is considered to be 6 times better for wetlands than NAA. As stated several times in the DEIS, the NAA serves as a basis for comparison of the impacts of the action alternatives. Please describe how the DEIS analysis of impacts meets the NEPA requirement to provide the decision-maker and public with a comparison of impacts." Correspondence #05*

Response: The no action alternative was analyzed in accordance with DO-12. The impacts of the breach are not static; they continue to occur over time with no action taken to restore the damage. As such, the action alternatives are evaluated relative to the impacts of the no action alternative over the same timeframe. As defined in the "General Analysis Methods" section of the "Environmental Consequences" chapter, restoration actions that move resource conditions toward the ecological reference condition, when compared to the no action alternative, are considered to be beneficial. The general methodology for the analysis has been revised to better clarify the assessment in terms of the relative change compared to the no action alternative.

Concern Statement 22: Risks associated with stream reconfiguration may be too great.

Comment: *"Rerouting of the stream could alter more ecosystems and seems to be an unnecessary risk." Correspondence #01*

Response: The NPS concludes that rerouting the stream will have net beneficial effects consistent with an acceptable level of risk. The design and engineering decisions and plans will be developed to avoid and minimize adverse effects to other ecosystems as much as practicable and consistent with restoration goals.

PURPOSE AND NEED

Concern Statement 23: The DEIS is inconsistent in indicating that the no action alternative would not meet the objectives of the plan.

Comment: *"The DEIS indicates NAA would not meet the objectives of the Purpose and Need (Table 2.7). The P/N is described as 'restore stream hydrological and groundwater processes, native plant communities, the stability of the hillside, wilderness character, wildlife and aquatic habitat, and water quality'. This is a somewhat ambiguous P/N, that according to the DEIS, would be achieved by the NAA. Please discuss this apparent discrepancy." Correspondence #05*

Response: After careful review of the DEIS we have concluded that there is no discrepancy. Table 2.7 in the EIS, evaluates the ability of the alternatives to meet the project objectives, which are more specific statements of the purpose. The no action alternative does not meet the objectives of the project. As detailed in the analysis, under the no action alternative, hydrological processes, wilderness character and ecological services would not be restored to an acceptable level over time. The hillside below the ditch would not be stabilized, water quality would continue to be degraded with significant precipitation events, and wilderness character would continue to be degraded due to the continuing evidence of the breach.

RULES AND REGULATIONS

Concern Statement 24: Evaluation of eagles in accordance with regulatory requirements needs to be clarified. Would there be a take under the Bald and Golden Eagle Protection Act?

Comment: *"P. 350 Please indicate if the breach resulted in take as defined by both the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act and, if so, please describe actions that were taken to compensate for the take." Correspondence #05*

Response: It is unlikely that a take (as defined by the Bald and Golden Eagle Protection Act) of either bald or golden eagles occurred as a result of the breach because there is no evidence in the historical record or from field observations that the area affected by the breach supported either bald or golden eagle populations or nesting, roosting or hunting activities.

It cannot be determined from the historical record and field evidence whether a take of migratory birds (as defined by the Migratory Bird Treaty Act) occurred in the area affected by the breach event. There were no pre-breach nesting bird surveys conducted in the affected area. However, it is unlikely that a migratory bird take occurred in this area because the breach occurred in the early spring (May 30), which is probably well before typical nest incubation occurs at the project site elevation.

Concern Statement 25: Issues statements in the DEIS include the effects of the 2003 breach which is inconsistent with DO-12. The breach damages are not impacts; they would not result from an alternative.

Comment: *"Pgs. 23 & 25 "Issues are usually problems that the current management practices have caused or that any of the proposed [should not exclude NAA] alternatives might cause." As defined by the Director's Order No. 12, issues are environmental, social, and economic problems or effects that may occur if the proposed action or alternatives (including no action) are implemented or continue to be implemented." This discussion is apparently supposed to focus on impacts from the alternatives. However, much of this section focuses on the impacts from the 2003 breach. The breach damages are not impacts, they would not result from an alternative. The breach created the problem that NPS now proposes to resolve but indicating the breach damages as issues is incorrect. Impacts are carried forth for analysis because of the impacts from the breach. Breach impacts are not alternative impacts. To be consistent a resource should not be considered because the breach impacted it, the resource should be considered because the alternative would restore the damage, therefore having beneficial impacts."*
Correspondence #05

Response: According to Section 2.5 of the DO-12 Handbook, "Issues are usually problems that either the 'no action' alternative has caused, or that any of the alternatives might cause…" There will be continuing degradation of the area impacted by the breach over time under the no action alternative (i.e., continual reworking of deposited sediments during peak runoff) and this degradation has been described as an issue to be evaluated.

PEPC Project ID: 24496, DocumentID: 46107 Correspondence

Author Information

Keep Private:	No
Name:	Jeffrey R. Metzger
Organization:	Director, The Three Lakes Watershed Association
Organization Type:	I - Unaffiliated Individual
Address:	1159 Ravenwood Road Boulder, CO 80303 USA
E-mail:	jrmetzger@prodigy.net

Correspondence Information

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Date Sent: 05/06/2012	Date Received: 05/06/2012
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Correspondence Text

Greetings.

After scanning the document, it's clear a tremendous amount of study and effort has gone into this process. We live in the Grand Lake area part of the year, and have hiked, fished and recreated in Grand County and RMNP for over 30 years. I'm also a Director of The Three Lakes Watershed Association.

RMNP is one of the crown jewels of the American Park System. The Colorado River, or "The Grand" is a crown jewel of the county, the state, and our namesake river.

We most likely only have one shot at this. The likelihood of getting in to the LuLu City area with equipment again is remote at best. I stongly support Maximum Restoration, as it may be our only chance to get in there for a very very long time, if ever again.

The silting of The Upper Colorado needs to be dealt with. Consistent lower water flows require some help with the shape of the river bottom. I'm less interested in historical river structure compliance, and more interested in a functioning river during lower flows. The silt and aggregates that come down the North Fork into Shadow Mountain Reservoir are also unacceptable. These particulates end up all over the CBT and Three Lakes due to water transport.

Let's get it right, with serious consideration that this may be our only shot and flows will continue to be low.

Best Regards,
Jeffrey R. Metzger

THE WATER SUPPLY AND STORAGE COMPANY

P.O. BOX 2017

FORT COLLINS, COLORADO 80522-2017

May 22, 2012

BY FEDERAL EXPRESS

Vaughn Baker, Superintendent
Rocky Mountain National Park
1000 HWY 36
Estes Park, CO 80517

Re: Comments to "Grand Ditch Breach Restoration Draft Environmental Impact Statement (March 2012)

Dear Superintendent Baker:

The following are the comments of the Water Supply and Storage Company ("WSSC" or the "Company") to the "Grand Ditch Breach Restoration Draft Environmental Impact Statement (March 2012)" prepared by the National Park Service.

The Notice of Availability for the DEIS was published in the Federal Register on March 9, 2012. According to the Notice, public comment will be accepted for 60 days from the date of the Notice or, in other words, until May 8, 2012; however, on the Service's website for the NEPA process and at the public workshops for the DEIS held by the Service, the Service stated that comments on the DEIS will be accepted until May 25, 2012.

General Comments

The Draft Environmental Impact Statement is inaccurate and misleading to the public. The primary restoration projects described in the preferred restoration alternative (Alternative D) for Zones 3 and 4 are not necessary as a result of the 2003 breach, nor do they restore natural resources impacted by the 2003 breach. Most of Zones 3 and 4 have already recovered in their entirety and ecological services have been restored.

The preferred restoration alternative should be subject to a separate NEPA process that clearly and correctly states that it is a series of new proposed projects by the NPS that are not related to the 2003 breach. The new projects include re-establishment of historic stream channels, installation of plant communities, neither of which existed at the time of the breach, and creation of additional flood storage.

The Council of Environmental Quality's NEPA regulations, 40 CFR § 1502.13, require an EIS to include a statement of purpose and need, which "shall briefly specify the underlying purpose and need to which the agency is responding ..." The statement of purpose and need in the DEIS states: "The purpose of this project is to restore the natural hydrological processes, ecological services, and wilderness character of the area in the Upper Kawuneeche Valley impacted by the 2003 Grand Ditch breach." As to Zones 3 and 4, this statement is incorrect.

Pursuant to the Park System Resource Protection Act, 16 U.S.C. § 19JJ-3(b), damages recovered under the Act must be used to "restore, replace, or acquire the equivalent of resources which were the subject of the action ..." Most of the preferred restoration alternative does not comply with the statutory requirement because it does not address impacts resulting from the breach and because it will unnecessarily cause additional harm to the natural environment.

Natural resource damage restoration may be either primary restoration or compensatory restoration. Although the DEIS cites Karl Cordova's 2007 report on compensatory restoration, the DEIS does not discuss compensatory restoration at all or justify any of the proposed restoration as compensatory. Further, the Cordova report focuses on five compensatory restoration projects, four of which apparently have been abandoned by the Service. The fifth, entitled "Compensatory Restoration at Kawuneeche Valley Restoration of Riparian Area," proposes only a fencing and oversight project intended to reduce browsing stress by elk and moose in the Zones 3 and 4 wetland areas. Clearly, the restoration proposed by the Service in the DEIS cannot be justified based on the purported need for compensatory restoration in these two zones.

Water Supply and Storage Company paid $9 million to resolve the natural resources damages case filed against it by the National Park service after the 2003 breach of the Grand River Ditch. Rather than use these funds for restoration of natural resources impacted by the 2003 breach, the NPS has proposed a series of new, independent projects in Zones 3 and 4 that are wholly unrelated to the 2003 breach or its impacts. The areas covered by the new projects have already recovered from the 2003 breach and ecological services have been restored. Zones 3 and 4 have adapted to the impacts of the 2003 breach as they have historically adapted to numerous natural deposition events that occurred prior to the 2003 breach. Ecological services in Zones 3 and 4 have also been restored. The preferred restoration alternative in these zones is unnecessary to comply with the Act and will cause unwarranted harm to the environment.

Specific Comments

Zone 1A

WSSC believes that Option 2 should be the preferred alternative. With correct engineering and construction techniques, this option will return the stability of the ditch bank back to, or greater than, its original condition and, with correct fill material and vegetative restoration, will minimize surface erosion in the area below the location of the breach.

Nevertheless, the NPS has preliminarily selected Option 1 as the preferred alternative. Assuming that fill is not going to be placed within the breach, this option will minimize further erosion of the original outer ditch bank, but will not stabilize the natural rock invert level of the exposed breach. This rock continues to weather due to its exposure and is desiccating due to freeze- thaw action. This is a very significant consequence of Option 1 that has been ignored in the DEIS. This option will not return the stability of the ditch bank back to, or greater than, its original condition.

In any event, if the NPS proceeds with Option 1, it must recognize and assume responsibility for the residual impairment to the Grand River Ditch and the attendant risk of another breach of the Ditch. The DEIS has not adequate or reasonably explained why it the preferred alternative would not include placement of fill material in the slope area below the breach location. WSSC will not bear further responsibility or liability for a breach of the Grand River Ditch in this location if the NPS proceeds with Option 2.

Zone 1B

According to the DEIS, the NPS intends to use spider-hoes to move equipment from the ditch road down to the top of Zone 1B. At one of the DEIS public meetings, however, NPS representatives stated that the NPS may construct a road through the fill material in Zone 1A to get to the top of Zone 1B. Construction of such a road could significantly impair the structural integrity of the Grand River Ditch and increase the potential for another breach. The same result could follow from improper operation of a spider-hoe.

The NPS assumes all responsibility and liability for the significant and adverse environmental consequences of moving equipment into Zone 1B from the ditch road as opposed from the bottom (i.e., through Zone 2 and the lower portion of Zone 1B). WSSC will not be responsible for such consequences. WSSC previously proposed that restoration of Zone 1B be conducted primarily through the use of hand tools and perhaps a mini-hoe lowered in and out of the zone by helicopter. These restoration methods would not adversely impact the integrity of the Grand River Ditch. The NPS should reconsider its preferred alternative for Zone 1B, but if it proceeds in the manner set forth it in the DEIS, it will assume responsibility for all consequential damages to the Ditch and the environment.

Zone 2

The magnitude of the equipment, including front-end loaders, excavators and backhoes, needed to remove the alluvial fan (Area F on Figure 2.21) will cause more harm because of the need to construct roads for the equipment, the disruption and destruction of vegetation resources and disturbance of hydrologic resources including stream channels. Placement of material removed from the alluvial fan requires new disturbances to Area G on Figure 2.21, which was not impacted by the breach. The same impact occurs in the upper-most portion of Zone 3, which is an extension of the alluvial fan.

The Preferred Restoration Alternatives for Zones 3 and 4 are, in fact, New NPS Projects

"Primary restoration" is the process of returning injured resources and associated services to their baseline conditions." The description of the preferred restoration alternative for Zones 3 and 4 contains no indication that this alternative is intended to promote primary restoration. Instead, the preferred alternative is a series of new resource projects initiated by the Service.

The wetland portion of Zones 3 and 4 have essentially recovered from the 2003 breach, are no longer injured and provide the same level of ecological and human services that they provided prior to the 2003 breach. The sedges and grasses in these zones have grown through any thin layers of sediment that may have been deposited by the 2003 breach, and this recovery occurs across the wetland. Excavation and removal of these thin layers of sediment is not necessary because much of the area has already recovered and the ecological services of the wetland area have been restored.

In addition, for Zone 3, the DEIS at 65 states: "To provide additional flood storage in this area, a series of 5- to 10-foot-wide cuts would be made through the sediment berms that have formed along approximately 900 feet of the east bank of the river (figure 2.22, area L)." The "sediment berms" along the river bank are the result of typical hydrologic processes occurring over many years and natural sediment transport through the basin. The sediment berms (Area L on Figure 2.22) are essentially the eastern bank of the Colorado River in Zone 3, which existed long before the 2003 breach. The proposal to make wide cuts through Area L to create additional flood storage in Area M is not, in any manner, related to the restoration of natural resources impacted by the 2003 breach.

Conditions in Zone 3 are the result of a normal hydrologic progression occurring over many years and resulting from numerous natural sediment deposition events prior to the 2003 breach. The sediment berms and other stream channel characteristics that currently exist in Zone 3 will likely re-form and will negate any purported benefit of the preferred restoration alternative.

Use of Area N in Zone 3 (Figures 2.22 and 2.23) as a staging area, temporary camp for workers and a helicopter landing pad will significantly and adversely impact the natural environment and the ability of this area to provide ecological services for decades and perhaps longer depending upon how well the NPS and its contractors manage noxious weed impacts. The DEIS should acknowledge that (and a separate NEPA document should be prepared because) this impact is not a direct result of the 2003 breach. The Area N impacts are also not an indirect effect of the 2003 breach because all of the Area N impacts all are in support of independent resource projects initiated by the NPS in Zones 3 and 4 that do not "restore, replace or acquire equivalent resources which were the subject to the action" within the meaning of the Park System Resource Protection Act.

The use of large excavation equipment in Zone 4 will cause extensive harm because of the need to construct roads for the equipment, the disruption and destruction of vegetation resources and disturbance of hydrologic resources including stream channels. The anthropogenic impacts to Area N discussed above under Zone 3 also apply to Zone 4.

The fundamental objective of the preferred restoration alternative in Zone 4 is to re-establish a historic channel for the Colorado River through the Lulu Creek wetland. The current channel configuration, however, is the same as the channel configuration that existed prior to the 2003 breach, particularly as to the channel along the western edge of Zone 4 (Area D on Figures 2.23 and 2.24) that the preferred restoration alternative proposes to abandon. Re-establishment of the historic channel does not restore any impact related to the 2003 breach.

The preferred restoration alternative also seeks to re-establish "tall willow complexes that were historically present." DEIS at 66. These complexes may have been present "historically," but there is no evidence they were present at the time of the 2003 breach or for a number of years before the 2003 breach. Re-establishment of this plant community may be a resource objective of the NPS, but it does not constitute restoration of natural resources adversely impacted by the 2003 breach and should not be represented as such in the DEIS.

The sediment that was deposited in Zone 4 by the 2003 breach did not prevent the regrowth of native vegetation in the wetland area. The preferred restoration alternative is not necessary and will cause significant adverse impacts to natural resources.

"Compensatory restoration" is "intended to replace a specific quantity of lost or diminished services. The lost or diminished service provided by a resource can involve either ecological services or human use services." NPS Damage Assessment and Restoration Handbook at 39. The description of the preferred restoration alternative for Zones 3 and 4 makes no attempt to justify the restoration alternatives as compensatory restoration, and any effort by the Service to do so in the final environmental impact statement would be extremely disingenuous.

The bibliography for the DEIS includes Karl Cordova's 2007 report on compensatory restoration (DEIS at 411), but the text of the DEIS does not so much as mention compensatory restoration. Further, the Cordova report focused on five compensatory restoration projects:

- Reforestation of former roadbeds at Sprague Lake;
- Reforestation of former roadbeds at Twin Sisters;
- Reforestation of ski slopes at Hidden Valley;
- Reforestation of riparian areas at Hidden Valley; and
- Restoration of riparian area at Kawuneeche Valley.

The first four of these compensatory restoration projects are not discussed in the DEIS and apparently have been abandoned by the Service. The fifth, entitled "Compensatory Restoration at Kawuneeche Valley Restoration of Riparian Area," proposes only a fencing and oversight project intended to reduce browsing stress by elk and moose. The Service has never proposed, or even contemplated, that the Zones 3 and 4 projects described in the preferred restoration alternative would be compensatory restoration projects for any breach-related impact.

The restoration proposed by the Service in the DEIS for Zones 3 and 4 cannot be justified based on the need for primary or compensatory restoration and should be described for what they are: immense new projects initiated by the Service for its own purposes that have no relation to the 2003 breach. The Service should rewrite the DEIS to clearly establish to the public that the severe and adverse environmental consequences that will follow from its proposal to excavate the beautiful and fully recovered wetlands and stream channels of Zones 3 and 4 are entirely of the Service's own making and should not be attributed in any manner to breach of the Grand River Ditch.

Please contact me if you have any questions or wish to discuss these comments further.

Very truly yours,

Eldon D. Marrs

Eldon D. Marrs
President

cc: WSSC Board of Directors
Dennis Harmon

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
DENVER, CO 80202-1129
Phone 800-227-8917
http://www.epa.gov/region08

MAY 2 3 2012

Ref: EPR/N

Mr. Vaughn Baker, Superintendent
Rocky Mountain National Park
National Park Service
1000 U.S. Highway 36
Estes Park, CO 80517-8397

Re: Grand Ditch Breach Restoration Draft Environmental Impact Statement

Dear Mr. Baker:

The U.S. Environmental Protection Agency (EPA) Region 8 has reviewed the Grand Ditch Breach Restoration Draft Environmental Impact Statement (EIS) prepared by the National Park Service (NPS) Our comments are provided for your consideration pursuant to our responsibilities and authority under Section 102(2)(C) of the National Environmental Policy Act (NEPA), 42 U.S.C. Section 4332(2)(C), and Section 309 of the Clean Air Act, 42 U.S.C. Section 7609. It is the EPA's responsibility to provide an independent review and evaluation of the potential environmental impacts of this project, which includes a rating of the environmental impact of the proposed action and the adequacy of the NEPA document.

Based on the EPA's procedures for evaluating potential environmental impacts on proposed actions and the adequacy of the information present, the EPA is rating the Preferred Alternative (i.e., Alternative D) a LO – Lack of Objections. A copy of EPA's rating criteria is attached.

Project Background and Description

The Grand Ditch is a 15-mile water diversion project, completed in 1937, in the Never Summer Mountains in the northwest region of Rocky Mountain National Park in Grand County, Colorado. Streams and creeks that flow from snow runoff on the eastern side of the Never Summer Mountains are diverted into the ditch, which flows over the continental Divide at La Poudre pass and delivers approximately 30,000 acre feet of water annually into the Cache La Poudre River. On May 30, 2003, a 100-foot section of the Grand Ditch breached its bank about 2.4 miles south of La Poudre Pass and approximately 22 acres and 1.5 miles of stream, riparian, upland and wetland habitat were injured. The estimated 47,600 cubic-yard debris flow resulted in channel morphologic changes, deposition of a large debris fan, increased sedimentation along the Colorado River, altered aesthetics of a wilderness area and tree mortality and scarring.

The purpose of the Grand Ditch Breach Restoration project is to restore the following:

- Stream hydrological and groundwater processes,
- Native plant communities,
- Stability of the hillside below the breach,
- Wilderness character of the area,
- Wildlife habitat,
- Aquatic habitat and
- Water quality in the affected area and downstream.

Restoration activities would take place during working hours for up to 3 months from June through September over a 2 to 3-year period. These would include: stabilizing banks through revegetation and re-contouring, removing debris from the alluvial fan and along the Colorado River, reconnecting the channel to the floodplain, creating terraces with debris and restoring the alluvial fan in one channel. Resources would be monitored for at least 20 years after the area has been restored.

Project Alternatives and Impacts

Five alternatives were analyzed in the Draft EIS – the no action and four action alternatives, ranging from minimal to maximum restoration. The NPS preferred alternative, Alternative D, was developed to achieve a high level of ecological restoration in a relatively short time. Alternative D is a composite of the other action alternatives that combines the most effective actions that could be accomplished within the project budget.

In the summer of 2003, Rocky Mountain National Park conducted surveys to assess the extent of damage generated by the breach. Following the settlement in 2006 of a civil lawsuit against the owners of the Grand Ditch, Water Supply and Storage Company, additional assessment work was conducted by park and Colorado State University researchers to refine knowledge of the area's current hydrology including stream hydrology, sediment transport, surface water-groundwater interactions and groundwater elevations. They compared these processes with those in nearby reference reaches (i.e., areas that had not been impacted by the breach).

The DEIS provided a good description of the methods, assumptions and impact thresholds used to analyze the project's direct and indirect impacts to natural resources, allowing the reader to quickly understand the basis for comparing the alternatives. Generally, the action alternatives would cause major short-term adverse impacts, but would ultimately create long-term beneficial impacts to natural resources.

Water Resources: There would be major short-term adverse impacts to water quality during restoration phases with Alternative D. However, long-term water quality conditions would experience a moderate beneficial improvement as restoration actions took effect. Alternative D would modify about 3,100 linear feet of bank and channel sides to protect sediment deposits from extensive slumping in the channels and eroding, and, if assessment assumptions are correct, returning the wetland surface and groundwater hydrologic conditions to pre-breach conditions.

Wetlands: Alternative D would have short-term, local, major adverse impacts on about 8.7 acres of wetland, stream channel and associated riparian areas due to the removal of sediment and existing wetland plants. However, the indirect effects of the restoration activities would beneficially affect a larger portion of the wetlands because suitable hydrology would be established. In addition, rerouting the Colorado River to return it to its historic channel and establishing and fencing off a large area to protect tall willow development from browsing elk and moose would result in long-term, local, substantial beneficial cumulative effects on wetlands.

Thank you for the opportunity to provide comments on the Draft Environmental Impact Statement for the Grand Ditch Breach Restoration Draft EIS. If you have any questions, please feel free to contact me at 303-312-6925 or the lead reviewer of this project, Carol Anderson, at 303-312-6058.

Sincerely,

Suzanne J. Bohan
Director, NEPA Compliance and Review Program
Ecosystems Protection and Remediation

cc by email: romo_superintendent@nps.gov

Enclosure/Attachment: EPA's Rating Systems for Draft Environmental Impact Statements

U.S. Environmental Protection Agency Rating System for Draft Environmental Impact Statements

Definitions and Follow-Up Action*

Environmental Impact of the Action

LO - - Lack of Objections: The Environmental Protection Agency (EPA) review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC - - Environmental Concerns: The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce these impacts.

EO - - Environmental Objections: The EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no-action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU - - Environmentally Unsatisfactory: The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

Adequacy of the Impact Statement

Category 1 - - Adequate: EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis of data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2 - - Insufficient Information: The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new, reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses or discussion should be included in the final EIS.

Category 3 - - Inadequate: EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the National Environmental Policy Act and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

* From EPA Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment. February, 1987.

PEPC Project ID: 24496, DocumentID: 46107
Correspondence

Author Information

Keep Private:	No
Name:	David Nickum
Organization:	Colorado Trout Unlimited
Organization Type:	I - Unaffiliated Individual
Address:	1536 Wynkoop Street Suite 100 Denver, CO 80003 USA
E-mail:	dnickum@tu.org

Correspondence Information

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Date Sent: 05/25/2012	Date Received: 05/25/2012
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Correspondence Text

Dear Superintendent Baker:

Colorado Trout Unlimited and its affiliated chapters engaged with conservation in Rocky Mountain National Park ? the Alpine Anglers, Colorado River Headwaters, and Rocky Mountain Flycasters Chapters - (hereafter referred to collectively as CTU) are pleased to have this opportunity to submit comments on the March 2012 Draft EIS that compares alternatives for reversing the adverse impacts resulting from the 2003 breach of the Grand Ditch in Rocky Mountain National Park (RMNP).

CTU has approximately 10,000 members associated with 23 chapters across the state of Colorado. They are advocates and conservators for their home rivers, conducting projects in stream restoration, water quality protection, and conservation of trout populations. These hands-on efforts by CTU chapter members, acting as volunteers, distinguish CTU from many other conservation groups. These efforts include extensive volunteer work with the National Park Service and RMNP. In terms of their time, energy and personal expenses, CTU volunteers are heavily invested, and continue to be highly interested, in the future of trout populations within the Park, thereby materially helping to maintain RMNP as an outstanding place for visitors to experience and learn about the Park's remarkable natural resources. In light of this ongoing interest, we offer the following comments regarding the Draft EIS.

CTU supports the Park Service's philosophy in choosing Alternative D

The 2003 breach of the Grand Ditch caused an egregious level of habitat destruction - a debris flow of 47,600 cubic yards of boulders, trees, and sediment that resulted in extensive injury to the vegetation, and to in-channel and floodplain habitat affecting at least 1.5 miles of stream, including parts of the Colorado

River. The large quantity of sediment deposited in the system caused changes to fish habitat (pool infilling, channel-bed substrate fining, aggradation, and loss of conveyance) that has been detrimental to the success of the trout populations. CTU is deeply concerned about the impacts, short and long term, that this event caused, and in particular, to the native fish communities of this critical ecological system.

It is clear that the DEIS addresses an opportunity to reverse those adverse impacts in one of four identified action alternatives. Each action alternative has its own short term adverse impacts and its associated long term desirable results.

The DEIS outlines five different restoration options to address the damage caused by the 2003 ditch breach. With one notable exception addressed below, these five options represent increasing degrees and spatial scales of restoration effort. While all four action alternatives contain common elements, only the Alternatives D and E can effectively address the ecological damage caused by the breach and meet the DEIS stated goals to restore systems that "are naturally dynamic and self-sustaining" (DEIS page i.). While CTU recognizes that Alternative E may, in the long term, provide the greatest environmental benefits, we agree with RMNP staff's opinion that the short term adverse impacts of alternative E are too significant. It does not make sense to attempt to more completely "undo" the effects of the breach and in the process create a much higher level of disruption to the ecosystem, rather than taking greater advantage of some of the natural stabilization that has already taken place since 2003. We therefore concur with RMNP staff in their decision that Alternative D represents the best option for the short and long term ecological restoration of the damaged ecosystem.

Further analysis is needed on potential impacts on trout fisheries

CTU is concerned by the DEIS' lack of detail with regard to impacts to the cutthroat trout population. The DEIS asserts that impacts to the cutthroat trout are both adverse and long-term, but concludes that the impacts will be minor. This conclusion seems based on the assumption that because healthy habitat exists upstream and downstream of the restoration area, the trout that will be displaced by closure of the existing main Colorado River channel as part of re-establishing the historical Colorado River channel will not be affected. The DEIS does not provide any information that allows for a proper evaluation of this assumption.

More generally, CTU recognizes that the main impacts of the restoration actions described in the DEIS are appropriately based on the sciences of geology, hydrology, geomorphology, and water chemistry. Biological sciences are applied in the DEIS mostly with respect to impacts on vegetation. But CTU observes that fisheries biology is addressed only to a limited extent.

With respect to fisheries biology, CTU believes the DEIS has only minimally addressed two critical issues, namely: (1) near-term impacts on existing trout populations now inhabiting and downstream of restoration Zone 4, and (2) long-term habitat needs of cutthroat trout in the Colorado River. It also fails to use existing available data from fish surveys conducted on behalf of RMNP.

With respect to these issues, the DEIS mentions that the Colorado River is the home of Colorado River cutthroat trout, a species of special concern (DEIS, page 343) and that there has been one observation of that species some 2 miles upstream of the restoration zone (DEIS, pages 205-206). However we have found no substantive data in the DEIS on the size of those populations; the specific stream reaches they inhabit; or the specific species of trout that will be impacted by the proposed restoration activities. Based on the fact that CTU volunteers have, in recent years, assisted a U. S. Fish and Wildlife Service biologist in conducting trout population surveys in the Lulu City wetlands (Restoration Zone 4), CTU is surprised that this data has apparently not been utilized in assessing impacts.

Although we do not have specific results of those surveys, TU volunteers were able to observe that there is a large population of trout in the Lulu City wetlands, perhaps more than a thousand in the reach of the Colorado River that is to be re-located. Presumably the specific data from these population surveys is available in the records maintained by Rocky Mountain National Park, and we recommend such data be examined to assist in determining mitigation actions that would be desirable during the habitat restoration work.

Further definition and planning is required for mitigating effects of channel relocation

Mitigation actions described in the DEIS seem mostly concerned with preventing adverse effects from movement of the rocks, soils and organic debris during restoration work, with seemingly little concern for near-term impacts on the fish and other aquatic life. Yet there will be intense adverse impacts on trout during relocation of the Colorado River channel in restoration Zone 4, and may be important impacts on fisheries downstream as well.

Areas color-coded P and S in Figures 2.23 and 2.34 of the DEIS depict the abandonment of approximately 2,700 feet of the existing Colorado River channel. The area to the east, color-coded Q, depicts the route of a new channel to be excavated along the historical route of the Colorado River. When the river's flow is diverted into the new channel, and the existing channel is de-watered, there is the potential for large numbers of trout to be stranded in the present channel. CTU is concerned that the DEIS has not adequately considered what should be done to assure the survival of the trout population in the existing river channel when inflows to the existing channel are terminated.

CTU's concern emanates from a similar re-routing of the Roaring River channel in RMNP where it crosses the alluvial fan. Not unlike the Grand Ditch breach, the Roaring River alluvial fan was created when an upstream earthen dam gave way, creating a flood that diverted Roaring River into a new channel that lacked the pool?riffle structure of the original channel. A remedial channel was designed to produce a more favorable habitat for trout similar to the original channel. After preparatory creation of the new channel, the diversion of water into the new channel was accomplished in a few minutes on November 6, 2006, leaving hundreds of trout, many of them native greenback cutthroats, in fast-drying small pools isolated from flowing water.

Fortunately, the US Fish and Wildlife Service biologist had a few days warning, and was able to gather about 20 CTU volunteers to help transfer those isolated trout into Fall River within a few hours. The rescue activity included recording the length, weight, species, and abnormalities of each displaced trout. The rescue was successful, averting what could have been a disaster for the trout in the impacted reach.

Unless the mitigation plan for re-routing the Colorado River in Zone 4 includes other means of safely re-locating trout from the channel to be abandoned, a similar rescue in the Lulu wetlands is likely to be needed. However, the logistics of getting people and equipment into the Lulu site are considerably more difficult than at Roaring River. So advance planning and notice of the timing of the water diversion will be essential. The DEIS (page 68) seems overly simplistic about the need for such planning when it says, "Instream flows would be maintained throughout the entire channel construction, diversion, and restoration operations".

Similarly, extensive reconstruction of the channel may result in significant release of sediment to downstream reaches where it could adversely effect fish populations. This issue should be addressed in defining mitigation measures and ? as described below ? in evaluating the appropriate extent and design of habitat reconstruction.

The EIS must better evaluate ? and respond to ? habitat needs of resident fish populations

We are also concerned that the EIS does not seem to treat the critical habitat requirements of Colorado River cutthroat trout (described in the DEIS at page 205) as an objective to be attained by the Preferred Alternative. Nor does the DEIS correlate the proposed physical changes in the Colorado River with expected effects on trout populations.

Alternative D relies on a mixture of native vegetation planting, channel morphology improvements, hydrologic restoration, and sediment management that could improve the habitat quality and flood storage capacity in the affected reaches and help return the system to a more natural and self-sustaining one. However, depending on the nature of channel morphology improvements ? and how they correlate to the habitat requirements of the resident trout population ? the project may fall short of its potential for sustainable fisheries as a natural and recreational resource of RMNP.

In Alternative D, the channel morphology improvements (and consequent trout habitat improvements) are substantially less than what is to be accomplished in either Alternatives C or E for restoration of the historical Colorado River channel through the Lulu wetland. These restoration actions are described as action "Q" on Maps 5 and 6 of each of Alternatives C, D, and E. (See DEIS Figures 2.18; 2.19; 2.23; 2.24; 2.28; and 2.29). Table 2.6, DEIS page 86, shows that the pertinent metrics for comparison of alternatives for Action Q in Zone 4 are the length of channel to be restored and the amount of aggradation to be removed in actions intended to restore the historical Colorado River channel. Table 2.6 shows that alternatives C and E will remove 6,600 cubic yards of aggradation over a channel length of 3,700 feet along the course of the historical channel, while Alternative D removes only 900 cubic yards from 500 feet of two short reaches in the historical channel. Certainly, this may be a case where "less can be more" in terms of reducing habitat disruption to the local and downstream areas and, on net, creating more fisheries benefit. However, that question cannot be answered without a careful examination of the proposed changes and their relationship to fish habitat needs, coupled with an assessment of downstream impacts from the construction activities.

The Colorado River is the southwestern United States' most significant river, and RMNP is its birthplace. Given the significance of this resource, we believe it is vital that RMNP dedicates the time and effort to first understand what approach to the channel work will most benefit the river and its resident fish population, and then provides the necessary resources to successfully complete work consistent with that approach. In the Final EIS, we look forward to seeing a more thorough examination of this issue, coupled with any changes in the proposed action that respond to the results of that examination.

Conclusions

CTU considers it vitally important that the Final EIS address the shortcomings of the Draft EIS mentioned above. More specifically, the Final EIS must include the following information in order to support the Park Service's final decision:

- provide specifics of existing trout populations in and near the restoration zones,
- describe the basis for assumptions about the presumed behavior of existing trout populations in their near-term reactions to channel relocations,
- incorporate a mitigation plan that minimizes near-term adverse impacts on the trout,

- incorporate an analysis of correlations between the long-term needs of trout for suitable habitat in all their life stages versus the habitat that will be created as a result of the restoration of the historic Colorado River channel,
- select an approach to and level of channel work that best addresses those habitat needs while minimizing any adverse downstream impacts from the construction process

CTU recognizes that development of the above information may require some additional efforts on the part of the agency's EIS team, but we believe the information will be essential in assuring the success of the restoration plan.

Finally, CTU anticipates that its volunteers may be of assistance during implementation of the restoration, much as they have been in the past. With that in mind, CTU welcomes informal discussions with the EIS team during development of the Final EIS on how our volunteers may be of help to RMNP in making this project a success.

For many years CTU volunteers have worked within Rocky Mountain National Park, helping staff members of the National Park Service and the U. S. Fish and Wildlife Service to carry out their missions. These efforts include:

- Assisting fishery biologists conducting trout population monitoring in waters throughout the Park, including the Colorado River within the proposed Grand Ditch Breach Restoration Zone 4.
- Supporting efforts to restore and preserve native cutthroat trout populations designated as species of special concern.
- Participating in habitat surveys and stream-flow measurements in the Poudre River headwaters preparatory to implementation of the National Park Service Record of Decision, Long Draw Reservoir, dated September 17, 2010.
- Conducting public outreach and education at Lily Lake to advise anglers of the special protections afforded to native cutthroats.

We stand ready to provide similar support to RMNP in successfully implementing your final restoration plans for the areas impacted by the Grand Ditch breach.

Thank you for the opportunity to comment, and we look forward to working with you to advance the restoration and protection of the Colorado River headwaters within Rocky Mountain National Park.

Sincerely,

David Nickum
Executive Director, Colorado Trout Unlimited

APPENDIX D: CONSULTATION

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United States Department of the Interior

NATIONAL PARK SERVICE
Rocky Mountain National Park
Estes Park, Colorado 80517

IN REPLY REFER TO:
H4217 (ROMO)

JAN 31 2012

Mr. Edward Nichols
State Historic Preservation Officer
Colorado Historical Society
1560 Broadway, Suite 400
Denver, CO 80202

Reference: **No Adverse Effect: Grand Ditch Breach Restoration Project**

Dear Mr. Nichols:

Rocky Mountain National Park is planning to mitigate damage that was done to park natural resources when the Grand Ditch, a trans-mountain water diversion canal, breached in the spring of 2003. This Section 106 consultation is being conducted in concert with the NEPA procedure.

This undertaking is located near the upper reaches of the Colorado River in Rocky Mountain National Park within Grand County. Please refer to a map of the project location for further details on this project.

The alternatives for natural resources restoration were developed to evaluate various magnitudes of restoration area and various techniques, or a combination of techniques, such as active revegetation, debris redistribution, engineered slope stabilization, or bank stabilization. Alternative A is the No Action Alternative. Alternatives B through E generally range from the least amount of restoration to the greatest amount of restoration. If during restoration previously unknown resources were discovered, work would immediately stop until the resources could be identified and documented. The National Park Service would initiate consultation with SHPO and affiliated tribes and an appropriate mitigation strategy would be developed.

The three cultural resources that are in the Area of Potential Effect are:

- The breached segment of the Grand Ditch (NRHP)
- An area of the Lulu City site (NRHP)
- Stewart's Wagon Road (5GA 2616)

Please look at the map to see the project area in orange/yellow shades. Determinations of Effect are for the following alternatives.

Alternative A: The alternative of no action would continue current management of the impacted area, following existing management policies and National Park Service guidelines. This alternative serves as a basis of comparison for evaluating the action alternatives.

An assessment conducted by a park archeologist following the breach concluded that no known archeological resources were impacted as a result of breach-related damage. There would be no excavations or ground-disturbing activities anticipated under Alternative A. While the events of 2003 likely impacted the National Register eligibility of the Grand Ditch in the breach area, there would be no construction activities under Alternative A with the potential to affect the historic fabric or character-defining features of the Grand Ditch. As such Alternative A would result in No Adverse Effect on the Grand Ditch, the wagon road, or the Lulu City area.

Alternative B: Minimal restoration would emphasize a smaller scale of management activity to restore portions of the impacted area using hand tools. This alternative would focus actions on areas that are unstable and present a high potential of continued degradation of existing ecosystem resources and services.

Ground disturbance would not occur in areas containing cultural resources. Overall, Alternative B would result in long-term beneficial impacts to the Grand Ditch due to the preservation of its linear entirety. Alternative B would result in No Adverse Effect on the Grand Ditch, the wagon road, or the Lulu City area.

Alternative C: High restoration, would involve more intensive management actions over large portions of the impacted area and use of motorized equipment. This alternative would focus actions on unstable areas that present a high to moderate potential of continued degradation of existing ecosystem resources and services.

Under Alternative C, impacts to the Grand Ditch would be the same as described under Alternative B. No actions were identified which would have an effect on cultural resources within the project area. Alternative C would have No Adverse Effect on the Grand Ditch, the wagon road, or the Lulu City area.

Alternative D (Preferred Alternative): This alternative includes placing fill into the breach area to stabilize the slope below the ditch in that segment and the use of motorized equipment. This will possibly reduce the potential for future breaches and enhance the protection of the resource by using soil nails and mesh. Ground disturbance from revegetation efforts would be minimal.

Under Alternative D, actions would be the same as described under Alternative C. The alternative would preserve the Grand Ditch's linear entirety. Alternative D would have No Adverse Effect on the Grand Ditch, the wagon road or the Lulu City Area.

Alternative E: Maximum restoration, would involve extensive management activity and use of motorized equipment to restore the project area to reflect both pre-breach and desired historical conditions. Engineered solutions would be used to stabilize banks and slopes to approximate pre-breach contours and to reduce transport of sediments over a larger portion of the impacted area. Extensive changes would be made to both the existing and past Colorado River channels to route the river to its alignment through the center of the Lulu City wetland before the breach.

Under Alternative E, actions would be the same as described in Alternative C, with the exception that a former wagon road would be crossed by a staging/haul road for heavy equipment. Remnants of the former wagon road may potentially fall within the staging/haul road. Should this overlap exist, protective measures such as temporary bridging or metal tracking would be installed in order to avoid impacts to any visible remnants of the wagon trail. In light of these mitigation measures, impacts to the wagon road could be avoided. The alternative would substantially preserve the Grand Ditch's linear entirety. Alternative E would have No Adverse Effect on the Grand Ditch, the wagon road, or the Lulu City area.

We believe these alternatives will have No Adverse Effect to cultural properties. Please provide Rocky Mountain National Park with your consultation consistent with your responsibilities under Section 106 of the National Historic Preservation Act. Please contact Karen Waddell, Cultural Resources Specialist at (970) 586-1332 if you have any questions or comments.

Sincerely,

Vaughn Baker

Vaughn L. Baker
Superintendent

Enclosures

February 22, 2012

Vaughn L. Baker
Superintendent
Rocky Mountain National Park
National Park Service
Estes Park, Colorado 80517

Re: No Adverse Effect: Grand Ditch Breach Restoration Project (CHS #57255)

Dear Mr. Vaughn:

Thank you for your correspondence dated January 31, 2012 (received by our office on February 7, 2012) regarding the subject project.

Following our review of the documentation provided, we concur that a finding of **no adverse effect** is appropriate for the proposed restoration work associated with Grand Ditch (site 5GA301), a resource listed to the National Register on September 29, 1976. This determination assumes that no additional historic properties (other than Grand Ditch) were affected by the breach in 2003 and that conditions as stated within the consultation letter are followed.

Please remember that the consultation process does involve other consulting parties such as local governments and Tribes, which as stipulated in 36 CFR 800.3 are required to be notified of the undertaking. Additional information provided by the local government, Tribes or other consulting parties may cause our office to re-evaluate our comments and recommendations.

Should unidentified archaeological resources be discovered during the course of the project, work must be interrupted until the resources have been evaluated in terms of the National Register of Historic Places eligibility criteria (36 CFR 60.4) in consultation with our office.

Thank you for the opportunity to comment. If we may be of further assistance please contact Mark Tobias, Section 106 Compliance Manager, at (303) 866-4674 or mark.tobias@state.co.us.

Sincerely,

Richard H Wilson

for Edward C. Nichols
State Historic Preservation Officer
ECN/MAT

United States Department of the Interior

NATIONAL PARK SERVICE
Rocky Mountain National Park
Estes Park, Colorado 80517

IN REPLY REFER TO:
L76 (ROMO)

JAN 3 1 2012

Sue Nall
Branch Chief Army Corp of Engineers
Colorado West Regulatory Branch
400 Rood Ave RM 142
Grand Junction, CO 81501-2563

Subject: Grand Ditch Breach Restoration Environmental Impact Statement, Rocky Mountain National Park

Dear Ms. Nall:

The National Park Service (NPS) is the lead agency for conducting environmental compliance under the National Environmental Policy Act for restoration of the 2003 Grand Ditch Breach, which occurred within Rocky Mountain National Park. We would like to bring you up-to-date on the current status of the process and begin consultation with the Army Corps of Engineers.

On May 30, 2003, the Grand Ditch, a trans-basin, water-diversion canal constructed in the late 1800s and early 1900s and located in the northwest corner of Rocky Mountain National Park, breached its bank. The breach saturated an adjacent hillslope which gave way, creating a debris flow that sent an estimated 47,600 cubic yards (around 5,000 dump truck loads) of mud, rocks, and trees cascading down into Lulu Creek and the headwaters of the Colorado River. The damaged areas include upland, stream, riparian, and wetland habitats within an approximate 22 acre area, 1.5-mile length. Lulu Creek flowed as a mud- and debris-filled torrent, gouging the streambed up to 6 feet deep, widening the channel by as much as 10 times, and uprooting and depositing piles of trees, sediment, and rocks throughout. When the torrent arrived at the confluence with the Colorado River, it deposited sediment and debris in an alluvial fan up to 6 feet thick. The sediment-filled waters continued down the Colorado River, clogging the channel in places and covering sections of the floodplain with gravel, sand, and debris. Further downstream, the flood arrived in the Lulu City wetland area where it filled existing channels and deposited up to 2 feet of silty sand into the wetland, burying existing vegetation and significantly altering the wetland's hydrologic regime. Approximately 50 plant species were impacted, and more than 20,000 trees were killed. The GPS coordinates for the Grand Ditch breach in the NAD 83 datum are 427866E, 4479092N.

In 2006, the U.S. Department of Justice, on behalf of the NPS, filed a civil lawsuit against the Water Supply and Storage Company, owners of the Grand Ditch, under the authority of the Park

System Resource Protection Act, which provides for the payment of compensation by private parties for damages to park resources. A settlement was reached in 2008.

The NPS has proposed to restore the hydrological processes, ecological services, and wilderness character of the area in the Upper Kawuneeche Valley impacted by the 2003 Grand Ditch breach. The overall objectives to restoring the impacted area include restoring appropriate stream and groundwater processes, appropriate native plant communities, the stability of the hillside below the breach site, wilderness character, wildlife habitat, aquatic habitat, and water quality in the affected area and downstream.

We want to make sure that the planning effort and the environmental compliance adequately addresses Army Corps of Engineers wetland concerns and needs related to the Grand Ditch Breach Restoration Draft Environmental Impact Statement (DEIS). When completed, the DEIS will be mailed to you with a request for your review and comment. A final EIS with selected alternative is planned to be completed by the end of 2012, when we will apply for a wetland permit through your office to complete the restoration work.

Included with this letter is a more detailed description of our preferred alternative along with project maps. We welcome any comments or suggestions you may have regarding this project.

We look forward to working with you on the planning and implementation of this important restoration project. If you have any questions, please contact:

Ben Bobowski (970) 586-1350 ben_bobowski@nps.gov, or

Jim Cheatham (970) 586-1301 jim_cheatham@nps.gov.

Sincerely,

Vaughn L. Baker

Vaughn L. Baker
Superintendent

Enclosures

United States Department of the Interior

NATIONAL PARK SERVICE
Rocky Mountain National Park
Estes Park, Colorado 80517

IN REPLY REFER TO:
L76 (ROMO)

JAN 3 1 2012

Susan Linner
U.S. Fish and Wildlife Service
P.O. Box 25486
Denver Federal Center (Mail Stop 65412)
Denver, CO 80225-0486

Dear Ms. Linner:

Enclosed please find a Biological Assessment (BA) for the Rocky Mountain National Park Grand Ditch Breach Restoration. We are also in the process of preparing a Draft Environmental Impact Statement (DEIS) for the Grand Ditch Breach Restoration. Also enclosed is the Unit Specific Species List for the national park. Your office most recently provided concurrence for this list on April 7, 2011.

The BA includes the following information:

1) A description of the action we are considering;
2) A description of the specific areas that may be affected by the proposed action;
3) A description of the species on the Unit Specific Species List that may be affected by the proposed action; and
4) A description of the manner in which the proposed action may affect any listed species or habitat and an analysis of cumulative effects.

Our effects determination for the Canada Lynx and wolverine is "may affect, but not likely to adversely affect." Our effects determination for the remaining species, specifically Colorado pikeminnow, razorback sucker, bonytail, humpback chub, Mexican spotted owl, and yellow billed cuckoo, on our Unit Specific Species List is "no effect."

We are seeking U.S. Fish and Wildlife Service (FWS) concurrence with our effects determinations.

During the preparation of the Grand Ditch Breach DEIS and the BA we have briefly conferred with Leslie Ellwood. She has been most helpful to us and we appreciate her insight.

The point of contact for the park is Ben Bobowski, Acting Deputy Superintendent. He can be reached at (970) 586-1350.

Sincerely,

Vaughn L. Baker
Superintendent

Enclosures

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Colorado Field Office
P.O. Box 25486, DFC (65412)
Denver, Colorado 80225-0486

IN REPLY REFER TO:
ES/CO: NPS/RMNP
ES/GJ-6-CO-99-F-033-CP-125

SEP 0 6 2012

Mr. Vaughn Baker
Superintendent
Rocky Mountain National Park
Estes Park, Colorado 80517

Dear Mr. Baker:

This responds to your letter received by the U.S. Fish and Wildlife Service (Service) on February 6, 2012, regarding the proposed Rocky Mountain National Park (NPS) Grand Ditch Breach Restoration Project in Grand County, Colorado. You requested concurrence with your determination that the proposed project may affect, but is not likely to adversely affect the Canada lynx (*Lynx canadensis*) and the North American wolverine (*Gulo gulo luscus*). Subsequent project discussions between the Service and NPS identified the potential for water depletions to occur from the Colorado River, resulting in the need to address the effects to the Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), bonytail chub (*Gila elegans*), and humpback chub (*Gila cypha*). Accordingly, you provided additional project information regarding water depletions (email, May 14, 2012).

In accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), and the Interagency Cooperation Regulations (50 CFR 402), the Service transmits this correspondence to serve as the final biological opinion for the Rocky Mountain National Park Grand Ditch Breach Restoration Project in Grand County, Colorado.

Project Description

The Grand Ditch is located near the upper end of the Kawuneeche Valley in the upper most portion of the Colorado River watershed. On May 30, 2003, a breach along the Grand Ditch caused a failure of the ditch, resulting in a large gully erosion of the hillslope below with a large debris flow continuing for at least 1.5 miles downstream. The proposed action is the restoration of the area impacted by the erosion and debris deposition from the breach. Work activities include, but are not limited to, reworking the exposed slope, placement of features to provide erosion protection, reseeding exposed soils with native grasses, removal of debris material, planting of tree seedlings where appropriate to site conditions, and excavation of the historic river channel.

Water depletions have been calculated for the proposed project, and include plant irrigation (0.49 acre-feet per year), equipment cleaning (0.007 acre-feet per year), retention pond evaporative loss (0.75 acre-feet per year), and dust abatement and material compaction (2 acre-feet per year) for a cumulative annual total of 3.247 acre-feet per year.

Based on the information provided in the biological assessment, the Service concurs with your determination that the proposed project may affect but is not likely to adversely affect the Canada lynx. While we do not consult on candidate species, we agree that the proposed action will result in only minimal impacts to the North American wolverine, a candidate species.

Colorado River Recovery Program

A Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin was initiated on January 22, 1988. The Recovery Program was intended to be the reasonable and prudent alternative for individual projects to avoid the likelihood of jeopardy to the endangered fishes from depletions from the Upper Colorado River Basin. In order to further define and clarify the process in the Recovery Program, a section 7 agreement was implemented on October 15, 1993, by the Recovery Program participants. Incorporated into this agreement is a Recovery Implementation Program Recovery Action Plan (RIPRAP) which identifies actions currently believed to be required to recover the endangered fishes in the most expeditious manner.

On December 20, 1999, the Service issued a final programmatic biological opinion for Bureau of Reclamation's Operations and Depletions, Other Depletions, and Funding and Implementation of Recovery Program Actions in the Upper Colorado River above the Confluence with the Gunnison River. The Service has determined that projects that fit under the umbrella of the Colorado River PBO would avoid the likelihood of jeopardy and/or adverse modification of critical habitat for depletion impacts. The Colorado River PBO states that in order for actions to fall within the umbrella of the PBO and rely on the Recovery Implementation Program Recovery Action Plan to offset its depletion, the following criteria must be met.

1. A Recovery Agreement must be offered and signed prior to conclusion of section 7 consultation.

2. A fee to fund recovery actions will be submitted as described in the proposed action for new depletion projects greater than 100 acre-feet/year. The 2006 fee is $16.67 per acre-foot and is adjusted each year for inflation.

3. Reinitiation stipulations will be included in all individual consultations under the umbrella of this programmatic.

4. The Service and project proponents will request that discretionary Federal control be retained for all consultations under this programmatic.

The Recovery Agreement was signed by the Service and the Water User. The depletions associated with this project are under 100 acre-feet/year, therefore, the project sponsor does not make a contribution to fund recovery actions. The NPS has agreed to condition its approval documents to retain jurisdiction should section 7 consultation need to be reinitiated. Therefore, the Service concludes that the subject project meets the criteria to rely on the Recovery Implementation Program Recovery Action Plan to offset depletion impacts and is not likely to jeopardize the continued existence of the species and is not likely to destroy or adversely modify designated critical habitat.

The reinitiation criteria for the Colorado River PBO apply to all projects under the umbrella of the PBO. For your information the reinitiation notice from the Colorado River PBO is presented below.

REINITIATION NOTICE

This concludes formal consultation on the subject action. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and under the following conditions.

a. The amount or extent of take specified in the incidental take statement for the Colorado River PBO is exceeded. The Service has determined that no incidental take, including harm, is anticipated to occur as a result of the depletions contemplated in this opinion because of the implementation of recovery actions. The implementation of the recovery actions contained in the Colorado River PBO will further decrease the likelihood of any take caused by depletion impacts.

b. New information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in the Colorado River PBO. In preparing the Colorado River PBO, the Service describes the positive and negative effects of the action it anticipates and considered in the section of the opinion entitled "Effects of the Action." New information would include, but is not limited to, not achieving a "positive response" or a significant decline in population, as described in Appendix D of the Colorado River PBO. Significant decline shall mean a decline in excess of normal variations in population (Appendix D). The current population estimate of adult Colorado pikeminnow in the Colorado River is 600 individuals, with a confidence interval of ± 250. Therefore, with the criteria established in Appendix D, a negative population response would trigger reinitiation if the population declined to 350 adults. The Recovery Program has developed recovery goals for the four endangered fishes. If a population meets or exceeds the numeric goal for that species, it will be considered to exhibit a positive response. The Service retains the authority to determine whether a significant decline in population has occurred, but will consult with the Recovery Program's Biology Committee prior to making its determination. In the event of a significant population decline, the Service is to first rely on the Recovery Program to take actions to correct the decline. If nonflow recovery actions have not been implemented, the Service will assess the impacts of not completing these actions prior to reexamining any flow related issues.

New information would also include the lack of a positive population response by the year 2015 or when new depletions reach 50,000 acre-feet/year. According to the criteria outlined in Appendix D of the Colorado River PBO, a positive response would require the adult Colorado pikeminnow population estimate to be 1,100 individuals (±250) in the Colorado River (Rifle, Colorado to the confluence with the Green River). When the population estimate increases above 1,100, a new population baseline is established at the higher population level.

c. The Recovery Action Plan actions listed as part of the proposed action in the Colorado River PBO are not implemented within the required time frames. This would be considered a change in the action subject to consultation; section 7 regulations (50 CFR 402.16 (c)) state that reinitiation of consultation is required if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion. The Recovery Action Plan is an adaptive management plan because additional information, changing priorities, and the development of the States' entitlement may require modification of the Recovery Action Plan. Therefore, the Recovery Action Plan is reviewed annually and updated and changed when necessary and the required time frames include changes in timing approved by means of the normal procedures of the Recovery Program, as explained in the description of the proposed action. In 2003 and every 2 years thereafter, for the life of the Recovery Program, the Service and Recovery Program will review implementation of the Recovery Action Plan actions to determine timely compliance with applicable schedules.

d. The Service lists new species or designates new or additional critical habitat, where the level or pattern of depletions covered under the Colorado River PBO may have an adverse impact on the newly listed species or habitat. If the species or habitat may be adversely affected by depletions, the Service will reinitiate consultation on the Colorado River PBO as required by its section 7 regulations. The Service will first determine whether the Recovery Program can avoid such impact or can be amended to avoid the likelihood of jeopardy and/or adverse modification of critical habitat for such depletion impacts. If the Recovery Program can avoid the likelihood of jeopardy and/or adverse modification of critical habitat no additional recovery actions for individual projects would be required, if the avoidance actions are already included in the Recovery Action Plan. If the Recovery Program is not likely to avoid the likelihood of jeopardy and/or adverse modification of critical habitat then the Service will reinitiate consultation and develop reasonable and prudent alternatives.

For purposes of any future reinitiation of consultation, depletions have been divided into two categories.

<u>Category 1</u>:

a) existing depletions, both Federal and non-Federal as described in the project description, from the Upper Colorado River Basin above the confluence with the Gunnison River that had actually occurred on or before September 30, 1995 (average annual depletion of approximately 1 million acre-feet/year);

b) depletions associated with the total 154,645 acre-feet/year volume of Green Mountain Reservoir, including power pool (which includes but is not limited to all of the 20,000 acre-feet contract pool and historic user's pool), the Colorado Big-Thompson replacement pool; and

c) depletions associated with Ruedi Reservoir including Round I sales of 7,850 acre-feet, Round II sales of 6,135 acre-feet/year as discussed in the Service's biological opinion to Reclamation dated May 26, 1995, and as amended on January 6, 1999, and the Fryingpan Arkansas Project replacement pool as governed by the operating principles for Ruedi Reservoir but excluding 21,650 acre-feet of the marketable yield.

Category 1 depletions shall remain as Category 1 depletions regardless of any subsequent change, exchange, or abandonment of the water rights resulting in such depletions. Category 1 depletions associated with existing facilities may be transferred to other facilities and remain in Category 1 so long as there is no increase in the amount of total depletions attributable to existing depletions. However, section 7 consultation is still required for Category 1 depletion projects when a new Federal action occurs which may affect endangered species except as provided by the criteria established for individual consultation under the umbrella of the Colorado River PBO. Reinitiation of this consultation will be required if the water users fail to provide 10,825 acre-feet/year on a permanent basis.

<u>Category 2</u>:

Category 2 is defined as all new depletions up to 120,000 acre-feet/year, this includes all depletions not included in Category 1 that occur after 1995 regardless of whether section 7 consultation has been completed. This category is further divided into two 60,000 acre-feet/year blocks of depletions.

The recovery actions are intended to avoid the likelihood of jeopardy and/or adverse modification of critical habitat and to result in a positive response as described in Appendix D of the Colorado River PBO for both 60,000 acre-feet blocks of depletions in Category 2. However, prior to depletions occurring in the second block, the Service will review the Recovery Program's progress and adequacy of the species response to the Recovery Action Plan actions. According to the criteria outlined in Appendix D, a positive response would require the adult Colorado pikeminnow population estimate to be maintained at approximately 1,100 individuals in the Colorado River (Rifle, Colorado to the confluence with the Green River), unless the criteria in Appendix D is changed because of new information. If the adult Colorado pikeminnow population is maintained at approximately 1,100 adults or whatever is determined to be the recovery goal in the Colorado River, a new population baseline would be established to determine a positive or negative population response.

When population estimates for wild adult humpback chub are finalized, they will also be used to determine population response. As outlined in Appendix D, Colorado pikeminnow and humpback chub population estimates will serve as surrogates for razorback sucker and bonytail to assess the status of their populations for 10 years. Recovery goals for all four species were completed August 1, 2002. If a population meets or exceeds the numeric goal for that species, it will be considered to exhibit a positive response. However, short of reaching a specific recovery goal, trends in certain population indices provide an interim assessment of a species' progress toward recovery. This review will begin when actual depletion levels from the first depletion block reach 50,000 acre-feet/year or the year 2015, whichever comes first.

Calculation of actual depletions is to be accomplished using Cameo gage records and State Division of Water Resources data (Appendix B of the Colorado River PBO). The review will include a determination if all the recovery actions have been satisfactorily completed, that all ongoing recovery actions are continuing, and the status of the endangered fish species. If it is determined that the recovery actions have all been completed and the status of all four endangered fish species has improved (based on criteria in Appendix D), then the Service intends that the Colorado River PBO would remain in effect for new depletions up to 120,000 acre-feet/year (total of both 60,000 acre-feet blocks of Category 2 depletions).

Monitoring, as explained in Appendix D, will be ongoing to determine if a population estimate of 1,100 (± one confidence interval) adult Colorado pikeminnow is maintained. If it is not maintained, this would be considered new information and section 7 would have to be reinitiated. Population baselines will be adjusted as population estimates change. If the adult Colorado pikeminnow population estimates increase, a new population baseline will be established to determine a positive or negative population response. If the population estimate for Colorado pikeminnow in the year 2015 is greater than 1,100 adults, then the higher number will be used to establish a new population baseline. These numeric values may be revised as new information becomes available. Revisions will be made to Appendix D as needed.

If the 50,000 acre-foot or 2015 review indicates that either the recovery actions have not been completed or the status of all four fish species has not sufficiently improved, the Service intends to reinitiate consultation on the Recovery Program to specify additional measures to be taken by the Recovery Program to avoid the likelihood of jeopardy and/or adverse modification of critical habitat for depletions associated with the second 60,000 acre-feet/year block. Any additional measures will be evaluated every 5 years. If other measures are determined by the Service or the Recovery Program to be needed for recovery prior to the review, they can be added to the Recovery Action Plan according to standard procedures, outlined in that plan. If the Recovery Program is unable to complete those actions which the Service has determined to be required for the second 60,000 acre-feet/year, consultation on projects with a Federal nexus may be reinitiated in accordance with Endangered Species Act regulations and this opinion's reinitiation requirements. The Service may also reinitiate consultation on the Recovery Program if fish populations do not improve according to the criteria in Appendix D or if any positive response achieved prior to the 50,000 acre-foot or the year 2015 is not maintained. Once a positive response is achieved, failure to maintain it will be considered a negative response.

If the Service reinitiates consultation, it will first provide information on the status of the species and recommendations for improving population numbers to the Recovery Program. The Service will reinitiate consultation with individual projects only if the Recovery Program does not implement recovery actions to improve the status of the listed fish species. The Service will reinitiate consultation first on Category 2 projects and second on Category 1 projects. The Service will only reinitiate consultations on Category 1 depletions if Category 2 depletion impacts are offset to the full extent of the capability of the covered projects as determined by the Service, and the likelihood of jeopardy to the listed fishes and/or adverse modification of critical habitat still cannot be avoided. The Service intends to reinitiate consultations simultaneously on all depletions within the applicable category.

If new information becomes available, if a new species becomes listed, if incidental take occurs, if the total average annual amount of water depleted by this project changes, or if any other project element changes which alters the operation of the project from that which is described in your correspondence and which may affect any endangered or threatened species in a manner or to an extent not considered in this biological opinion (see 50 CFR 402.16), formal section 7 consultation should be reinitiated. The NPS has agreed to condition its approval documents to retain jurisdiction should section 7 consultation need to be reinitiated.

If you have any questions regarding this consultation or would like to discuss it in more detail, please contact Leslie Ellwood of the Ecological Services Field Office in Lakewood, Colorado at (303) 236-4747.

Sincerely,

Susan C. Linner

Susan C. Linner
Colorado Field Supervisor

cc: FWS/UCREFRP, Denver

Ref: Projects\NPS\RMNP\NPS_RMNP Grand Ditch Breach_FWS BO

United States Department of the Interior

NATIONAL PARK SERVICE
Rocky Mountain National Park
Estes Park, Colorado 80517

IN REPLY REFER TO:
L76 (ROMO)

JAN 3 1 2012

The Honorable Elain Atcitty, Chairwoman
White Mesa Ute
PO Box 7096
Blanding Utah, 84511

Reference: Grand Ditch Breach Restoration Project

Dear Ms. Atcitty,

The National Park Service, which administers Rocky Mountain National Park, is planning to restore damage that was done to park resources when the Grand Ditch, a trans-mountain water diversion canal, breached in the spring of 2003. This project is located near the upper reaches of the Colorado River in Rocky Mountain National Park within Grand County, Colorado. Please refer to the enclosed newsletter for a map of the project location and further details on this project. The newsletter was mailed to the White Mesa Ute May 2010.

The National Park Service is in the process of preparing a Draft Environmental Impact Statement (DEIS) under the National Environmental Policy Act (NEPA) to evaluate several alternatives for repairing the damage that was caused by the breach. The DEIS will be available for public review and comment within the next few weeks, and we will notify you when it is available. In the meantime, we would welcome any input you would like to provide on the Grand Ditch Breach Restoration Project, and we would welcome the opportunity to meet with you in person regarding this project if you wish.

If you should have any questions or comments regarding the Grand Ditch Breach Restoration Project, please contact Ben Bobowski. He can be reached at (970) 586-1350 or Ben_Bobowski@nps.gov.

Sincerely,

Vaughn Baker

Vaughn L. Baker
Superintendent

Enclosure

APPENDIX E: ALTERNATIVES COST MATRICES

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ROCKY MOUNTAIN NATIONAL PARK GRAND DITCH BREACH RESTORATION ENVIRONMENTAL IMPACT STATEMENT

SUMMARY OF ALTERNATIVES

	RESTORATION ALTERNATIVES				
PROJECT ELEMENT	ALT. A No Action	ALT. B Minimum	ALT. C High	ALT. D Preferred	ALT. E Maximum
Construction Cost	$ -	$2,376,294	$4,621,390	$3,718,848	$7,554,583
Construction Equipment Purchase	$ -	$ -	$160,000	$160,000	$160,000
Helicopter Services	$ -	$ -	$1,000,000	$1,000,000	$1,000,000
Mitigation Costs (5-20%)	$ -	$118,815	$924,278	$743,770	$1,510,917
Construction Labor	$ -	$ -	$ -	$ -	$ -
Subtotal	$ -	$2,495,108	$6,705,668	$5,622,618	$10,225,499
NPS Contractor Supervision (8%)	$ -	$199,609	$536,453	$449,809	$818,040
Remoteness Factor (15%)	$ -	$374,266	$1,005,850	$843,393	$1,533,825
Construction Contingency (10%)	$ -	$249,511	$670,567	$562,262	$1,022,550
Engineering Design Services (15%)	$ -	$374,266	$1,005,850	$843,393	$1,533,825
Contractor Overhead (8%)	$ -	$199,609	$536,453	$449,809	$818,040
Contractor Profit (10%)	$ -	$249,511	$670,567	$562,262	$1,022,550
Total		$4,141,880 (option 1) or $5,537,873 (option 2)	$11,131,409 (option 1) or $12,726,830 (option 2)	$9,333,546	$16,974,329 (option 1) or $18,569,750 (option 2)
Acres Affected by Construction	0	2.57	18.89	19.28	37.12
Cubic Yards Excavated/Stored	0	6,642	83,675	77,723	175,592
Linear Feet Channel/Bank Modifications	0	1,054	9,763	7,419	10,104
Construction Years (including Zone 1A)	0	2	2	2	2 to 3

Note: Two cost values are given for alternative B, C, and E depending on whether option 1 or 2 is applied in zone 1A. Under alternative D, option 1 would be applied to zone 1A and therefore only one cost is given.

Construction cost estimates are based on 15 percent preliminary design. As a result, the range of error in the cost estimates could be as high as +/-50 percent in some locations within the project area and as low +/- 10 percent in other locations. In total, the cost estimates are within the accepted industry accuracy range of Class C estimates of -30% to +50% (NPS 2007b)

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APPENDIX F: WILDERNESS MINIMUM REQUIREMENT DECISION GUIDE

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ROCKY MOUNTAIN NATIONAL PARK

MINIMUM REQUIREMENTS DECISION GUIDE

WORKSHEETS

". . . except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act..."

– the Wilderness Act, 1964

Please refer to the accompanying MRDG *Instructions* for filling out this guide.
The spaces in the worksheets will expand as necessary as you enter your response.

The MRDG Instructions may be found at: http://www.wilderness.net/mrdg/

Project Title: Grand Ditch Breach Restoration Environmental Impact Statement (EIS)

Step 1: Determine if any administrative action is necessary.

Description: Briefly describe the situation that may prompt action.

On May 30, 2003 a breach along the Grand Ditch caused an overtopping of the ditch, which initiated gully erosion on the hillslope below the ditch. The resulting debris flow of 47,600 cubic yards of boulders, trees, and sediment entered Lulu Creek and continued downstream to the Colorado River. A debris fan was deposited at the confluence of Lulu Creek and the Colorado River. Evidence of extensive injury to vegetative communities and in-channel and floodplain erosion and deposition resulting from reworking of the debris flow material is prominent for at least 1.5 miles downstream to the lower end of the Lulu City wetland. The site is located within designated wilderness in the northwest region of Rocky Mountain National Park.

Research conducted in the park indicates that landforms, hydrologic regime, and vegetation within the Upper Kawuneeche Valley have been highly impacted by the 2003 breach, and previous debris flows. The area of impact contains more sediment, debris, and subsequent damages from the Grand Ditch breach event than it would under natural conditions, affecting the ecological services of the area. One of the most prominent impacts is the alteration of the hydrologic regime and subsequent plant communities in the Lulu City wetland. Other impacts include impacts to aquatic, riparian, and upland ecosystems, impacts from downstream sedimentation causing turbidity and sedimentation throughout and beyond the project area, erosion, large deposits of debris, and lost vegetation.

To determine if administrative action is necessary, answer the questions listed in A - F on the following pages by answering Yes, No, or Not Applicable and providing and explanation.

A. Describe Options Outside of Wilderness

Is action necessary within wilderness?

Yes: ☒ **No:** ☐

Explain: The majority of the area impacted by the 2003 Grand Ditch breach is within designated wilderness and cannot be relocated.

B. Describe Valid Existing Rights or Special Provisions of Wilderness Legislation

Is action necessary to satisfy valid existing rights or a special provision in wilderness legislation (the Wilderness Act of 1964 or subsequent wilderness laws) that allows or requires consideration of the Section 4(c) prohibited uses? Cite law and section.

Yes: ☐ **No:** ☒ **Not Applicable:** ☐

Explain:

C. Describe Requirements of Other Legislation

Is action necessary to meet the requirements of other laws?

Yes: ☐ **No:** ☒ **Not Applicable:** ☐

Explain:

D. Describe Other Guidance

Is action necessary to conform to direction contained in agency policy, unit and wilderness management plans, species recovery plans, or agreements with tribal, state and local governments or other federal agencies?

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Under the 2006 NPS *Management Policies*, the National Park Service is obligated by law and policy to maintain and restore, to the extent possible, the natural conditions and processes in park units (section 4.1.5). The Upper Kawuneeche Valley area of impact contains more sediment, debris, and subsequent damages from the Grand Ditch breach event than it would under natural conditions.
NPS *Management Policies* (NPS 2006) direct managers to strive to maintain the components and processes of naturally evolving park ecosystems. These policies also recognize that if biological or physical processes were altered by human activities, they may need to be actively managed (i.e., their recovery accelerated) to restore them to a natural condition or to maintain the closest possible approximation of the natural condition.
Section 4.4.1.1 requires that the National Park Service "adopt park resource preservation, development, and use management strategies that are intended to maintain the natural population fluctuation and processes that influence the dynamics of individual plant and animal populations, groups of plant and animal populations, and migratory animal populations in parks".

Section 6.3.7 of the NPS Reference Manual #41 – Wilderness Preservation and Management (RM-41) recognizes that wilderness is a composite resource with interrelated parts.

> "Without spectacular natural resources, especially indigenous and endemic species, a wilderness experience might not be possible. Natural resources are critical, defining elements of the wilderness resource, but need to be managed within the context of the whole. Natural resources management in wilderness will include and be guided by a coordinated program of scientific inventory, monitoring, and research."

The NPS RM-41 further states that

> "The principle of non-degradation will be applied to wilderness management, and each wilderness area's condition will be measured and assessed against its own unimpaired standard. Natural processes will be allowed, in so far as possible, to shape and control wilderness ecosystems. Management should seek to sustain natural distribution, numbers, population composition, and interaction of indigenous species. Management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and the influences originating outside of wilderness boundaries. Management actions, including restoration of extirpated native species, altered natural fire regimes, controlling invasive alien species, endangered species management, and the protection of air and water quality, should be attempted only when the knowledge and tools exist to accomplish clearly articulated goals."

The *Backcountry Wilderness Management Plan and Environmental Assessment* for the park states that aquatic ecosystems will be managed to maintain and restore natural processes and native species indigenous to the Park. The 2003 Grand Ditch breach impacted the aquatic ecosystems along Lulu Creek and the Colorado River.
Additional guidance exists in NPS Director's Order #14 "Resource Damage Assessment and Restoration" which states that, when defining restoration needs, "In all cases, the NPS will consider primary restoration on-site and in-kind, whenever, and wherever feasible to do so.

E. Wilderness Character

Is action necessary to preserve one or more of the qualities of wilderness character including: Untrammeled, Undeveloped, Natural, Outstanding opportunities for solitude or a primitive and unconfined type of recreation, or other unique components that reflect the character of this wilderness area?

Untrammeled: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: If restoration of the impacted area does not occur, then evidence of the breach will remain in the impacted area. The 2003 breach, and previous breaches occurred because of human manipulation of the natural ecological processes and drainage patterns of the Never Summer Mountains and as such represents trammeling of the landscape. Debris deposits, bare areas, and the homogeneous wetland species population would continue to serve as a highly visible scar on the untrammeled wilderness that surrounds the area. Restoration will diminish the visible evidence of the breach and restore ecological and hydrologic processes to preserve the wilderness character of the area. Restoration activities would entail short-term human control or manipulation, with the objective of reestablishing and/or maintaining sustainable ecological conditions. Human manipulations during restoration activities would have a short term impact to the untrammeled quality of wilderness. The likelihood and magnitude of the impact will vary among alternatives.

Undeveloped: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain: During restoration activities, temporary structures and habitations would be erected to house restoration workers and browsing exclosures could be used to protect willow plantings. Additionally, restoration could require the use of motor vehicles, motorized equipment, and/or mechanical transport within and/or adjacent to the wilderness area. Under some alternatives, fences would be installed to protect planted willows from herbivory. Fences, although not permanent, would be evidence of human modification over the 10-15 year planning period. Restoration activities would not include the development of any permanent structures.

Natural: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Restoration activities would improve the unnatural ecological and hydrologic processes introduced into the area by the Grand Ditch breach.

The presence of mitigation measures, temporary line camps, disturbance of surface waters during bank stabilization, disturbance and sedimentation, and the creation of debris terraces during restoration activities may be short term impairments of this quality. The likelihood and magnitude of the decrease will vary among alternatives.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation:

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain: The actions associated with action alternatives would have short term adverse impacts to solitude and primitive components of wilderness character. There would also be long-term benefits to the primitive character of this area. Any enhancement of opportunities for solitude or primitive and unconfined recreation that results from restoration are because of the long term contribution to protecting or restoring the natural quality.

The potential loss of opportunities for solitude or primitive recreation due to workers using motorized equipment and temporary trail and campsite closures may result in a short term impact to this quality. The likelihood and magnitude will vary among alternatives and might be lessened by mitigation.

Other unique components that reflect the character of this wilderness:

Yes: ☐ **No:** ☐ **Not Applicable:** ☒

Explain:

F. Describe Effects to the Public Purposes of Wilderness

Is action necessary to be consistent with one or more of the public purposes for wilderness (as stated in Section 4(b) of the Wilderness Act) of recreation, scenic, scientific, education, conservation, and historical use?

Recreation: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Restoration would benefit the natural conditions and functions of ecological and hydrologic processes within the wilderness area impacted by the 2003 Grand Ditch breach. Restoration would improve scenic opportunities that visitors come to the park to enjoy.

Scenic: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Restoration of the area impacted by the 2003 Grand Ditch breach would restore natural conditions in the wilderness and would reduce the visual evidence of damages caused by the 2003 Grand Ditch breach. Removal of debris, bank stabilization, and revegetation would restore the scenic qualities of the wilderness within the project area.

Scientific: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Monitoring data collected as part of this restoration effort will further scientific knowledge of ecological restoration related to debris deposition and impacts to ground and surface water interactions.

Education: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: All action alternatives involve a component to further educate the public on the effects of the breach on native ecological systems in the park and the effects that management actions would have on restoring native ecological components to wilderness areas.

Conservation: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Restoration would benefit the natural conditions and functions of ecological and hydrologic processes within the wilderness area impacted by the 2003 Grand Ditch breach. Reducing sedimentation and revegetation would result in an increase in diversity of the park's wildlife and plant species. Improving these habitats protects scenic and recreational opportunities which visitors come to the park to enjoy.

Historical use: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain: Historical use of the wilderness area was not impacted by the 2003 Grand Ditch breach and would not be affected over the long term as a result of restoration.

Step 1 Decision: Is any administrative action necessary in wilderness?

Yes: ☒ **No:** ☐ **More information needed:** ☐

Explain: Given the well documented impacts to ecologic and hydrologic processes in the project area resulting from the 2003 Grand Ditch breach, the National Park Service believes it is necessary to restore the area to less impacted, more natural conditions. Actions taken to restore the damage created by the breach would greatly reduce or eliminate the impacts of continued erosion and restore natural processes in wilderness. The environmental impact statement concludes that if no action is taken to restore ecological and hydrologic conditions in the area impacted by the breach, there would be continued moderate to major adverse impacts to wilderness character, hydrologic conditions, and wetland vegetation.

If action is necessary, proceed to Step 2 to determine the minimum activity.

Step 2: Determine the <u>minimum</u> activity.

Please refer to the accompanying MRDG *Instructions* for information on identifying alternatives and an explanation of the effects criteria displayed below.

Description of Alternatives

For each alternative, describe what methods and techniques will be used, when the activity will take place, where the activity will take place, what mitigation measures are necessary, and the general effects to the wilderness resource and character.

The alternatives described below correspond to the alternatives evaluated in the environmental impact statement. The actions are described in detail in the "Alternatives" chapter of the environmental impact statement and summarized below.

The area of impact was analyzed by the approximate extent of debris deposition and injury to ecological and hydrologic functions caused by the Grand Ditch breach. The injured area is divided into four zones representing different geo-ecological areas (refer to figure 1.5 in the environmental impact statement).

Zone1. Zone 1 is the steep gullied hillside immediately below the breach site to the point where a perennial stream surfaces above Lulu Creek. This area is outside of the wilderness.

Zone 1A. Zone 1A is the bare, road-cut hillside immediately below the Grand Ditch. This area was previously disturbed during construction of the ditch. This zone does not fall within the wilderness boundary.

Zone 1B. Zone 1B consists of the forested hillside below zone 1A. This area is within wilderness.

Zone 2. Zone 2 is the active channel where a perennial stream surfaces and flows into Lulu Creek to the confluence of Lulu Creek with the Colorado River. This area is within wilderness.

Zone 3. Zone 3 includes the Colorado River from its confluence with Lulu Creek (zone 2) downstream to the Lulu City wetland (zone 4). This area is within wilderness

Zone 4. Zone 4 is the section of Lulu City wetland impacted by the breach. This area is within wilderness.

Alternative A, No Action

Description:
Under this alternative, restoration of the area impacted by the 2003 Grand Ditch breach would not occur. For zone 1A only, this alternative violates stipulations within the 2008 settlement agreement between the National Park Service and the Water Supply and Storage Company (WSSC) to take action to restore this area, in order to prevent further failure of the Grand Ditch. Under this alternative, the project area would recover passively with no management actions to facilitate or accelerate that recovery. As a result, the hydrologic and ecological recovery would occur gradually and would achieve less than 50% of the restoration goals within 100 years. Some alterations of the wilderness would remain permanent.

Effects:
Under alternative A, no action would be taken to restore the hydrologic and ecological conditions of the project area that continued to be affected by breach. The high level of impacts to the natural and untrammeled qualities of wilderness would continue to be long-term, as described below.

Wilderness Character

"Untrammeled" – Under the no action alternative, damages caused by the 2003 Grand Ditch breach, as a result of human manipulation of ecological systems, would continue to adversely impact the untrammeled wilderness quality in the project area over the short and long term.

The following condition(s) within each zone would continue to impact the untrammeled quality of wilderness over the short and long term as the human caused manipulation or damage to the environment would be evident:

- The steep gully created from the breach in zone 1A and 1B is unlikely to fill in naturally and would leave a scar on the landscape;

- Unstable soil in the project area, and the large volume of sediment within the main stream channel and the alluvial fan in zone 2 would continue to erode and degrade, negatively affecting hydrologic processes and aquatic ecology which impact the wilderness character.
- Sediment deposited in zone 4 unnaturally restricts the Colorado River to the western side of the wetland at an elevated ground surface relative to the summer water table. The untrammeled quality of the wilderness would be impacted by the human caused degradation evidenced in homogenous vegetation and sheet flow conditions present in the wetland that are different from the conditions that would be found naturally.

"Undeveloped" – Under the no action alternative, the park would continue current management of the project area consistent with the park's wilderness designation prohibiting permanent improvements. No permanent structures or enhancements would be present in wilderness as a result of the breach event, and there would continue to be no impact on the undeveloped quality of wilderness.

"Natural" – Under the no action alternative, the following condition(s) within each zone would continue to impact the natural quality of wilderness over the short and long term in that the natural ecological relationships and processes that had existed prior to the breach would be interrupted or permanently altered:

- The loss of upland forest in zone 1B would take up to 200 years to recover naturally and would continue to degrade the natural quality of the wilderness due to the resulting loss of habitat and changed vegetation. The steep and unstable gully created by the breach in zones 1A and 1B is unlikely to fill in naturally and would continue to degrade the natural quality of wilderness by contributing to erosion and downstream sedimentation that impact hydrologic and ecologic processes;
- Erosion and impacts to natural hydrologic processes from loss of upland vegetation, altered land forms, and large volumes of debris deposited within Lulu Creek (zone 2) and the Colorado River (zone 3) would continue to degrade the natural quality of the wilderness by altering habitat and water quality;
- Impacts to natural hydrologic process resulting from sediment deposits up to 20 inches thick confine the Colorado River to the western side of the wetland and create unnatural sheet flow conditions in zone 4. These conditions degrade the natural quality of the wilderness by resulting in an altered vegetative community dominated by sedge species as a result of the elevated ground surface relative to the summer water table.

Alternative A would not alter current conditions or the management of the area. In zones 1B through 4, some stabilization has occurred naturally since 2003, however, full recovery of forested habitat and community functions throughout the project area would take up to 200 years. Natural recovery of the project area would continue slowly with some alteration of the wilderness remaining permanent.

"Outstanding opportunities for solitude or a primitive and unconfined type of recreation" – Under the no action alternative, access in the wilderness within the project area would continue to be limited to foot and horse use. Recreational developments within the wilderness area would continue to include marked trails, pit toilets, backcountry campsites, and signs within the class 3 wilderness corridors. Access and use of these developments would continue to enhance opportunities for unconfined recreation.

The effects of the 2003 Grand Ditch breach would continue to be present and highly visible from many locations within wilderness. Impacts to the untrammeled and natural wilderness qualities would continue to degrade the primitive and unconfined aesthetics of solitude reducing, to a large degree, opportunities for primitive recreation over the short and long term.

Other unique components that reflect the character of this wilderness – Not applicable.

Heritage and Cultural Resources – An archeological site, comprised of the remains of Lulu City, is situated in a large meadow within a lodgepole pine forest east of the Colorado River floodplain, and within the project area. Lulu City was listed on the National Register of Historic Places on January 29, 1988. Visible remnants of wagon roads also exist in the area of Lulu City. The breach itself had no effect on these archeological resources. Under alternative A, no action would be taken within the Lulu City archeological site or associated wagon roads and therefore there would be no effect to these resources. .

Maintaining Traditional Skills – Not applicable.

Special Provisions – None identified.

Economics and Timing Constraints: Since there are no actions being taken, there are no economic or time constraints.

Additional Wilderness-specific Comparison Criteria – None identified.

Safety of Visitors, Personnel, and Contractors – As no restoration actions would be undertaken under alternative A, there are no effects to human health and safety from restoration activities. However, there would be safety risks to visitors and park staff as a result of high spring flows combined with a readily available source of sediment and debris that could wash out bridges and trails within the area, such as occurred in the spring of 2011.

Actions Common to All Action Alternatives

Vegetation Restoration

The restoration of vegetation within the project area would occur to varying degrees under each of the alternatives. At a minimum, the following would be conducted: Seeding, using native seed of the same germ plasm as those in the watershed and small trees and shrubs would be used primarily in zones 1B, 2, and 3 to stabilize areas disturbed by the breach event or from restoration actions. To maintain the seed in place, natural fiber erosion control blankets would be used to hold the seed until germination. The erosion blankets would be secured using manufactured stakes and available cobbles where feasible. Erosion control blankets would degrade in place over a three to six year period and degradable stakes used to secure them would be left to gradually decompose. In the wetland locations, sprigs of sedges or cuttings of tall willows would be planted by hand, depending upon the alternative. All plant material used in this restoration action would need to meet the genetic similarity requirements of the park's current vegetation restoration management plan (NPS 2006).

Resource Monitoring

Under each of the action alternatives, changes in stream and groundwater hydrology, water quality, and vegetative recovery would be monitored in the restoration area. Groundwater pit tests and stream gauges would be placed to monitor the recovery of hydrologic conditions over the long-term. These would be removed when monitoring was complete.

Alternative B

Description:

Restoration of Zone 1A:

Option 1

Stabilize existing scar using a tie back anchor system. Soil anchor nails would be used to stabilize the scar and steel mesh would be placed over the slope face. Specific surface treatments such as geocell installation, rock mulching, or gabions may be required to control shallow, surficial flow slides and provide erosion protection. Optional components include installing a reinforced earth cap along the ditch road or use of vertically-installed micropiles to provide further stabilization. Figure 2.1 in the environmental impact statement provides a graphical representation of this option.

Or

Option 2

Backfill existing scar with compacted, reinforced earth fill to restore the original, pre-breach topography. Fill would be compacted in lifts over the existing fill and reinforced with synthetic geogrid reinforcement and anchored into the existing hill slope using a tieback system. Excavate into the slope of the uphill side of the existing culvert pipes and install a third culvert barrel through the breach area. Fill material would be obtained from Long Draw Reservoir. Figure 2.2 in the environmental impact statement provides a graphical representation of this option.

Under both options, equipment that would be expected to be used in the restoration activities include, but are not limited to, bulldozers, excavators, front end loaders, dump trucks, and water trucks. Some of this equipment would need to be specialized for use in very steep areas.

Equipment staging and stockpiling of materials before transport to zone 1A would be along the Grand Ditch roadway in an area that has been previously disturbed, either graveled, cleared, or in a non-vegetated condition. Construction equipment would access the project area using the roadway.

The restoration work in Zone 1A would require two years to complete. The area within 200 horizontal feet of the centerline of the Grand Ditch is not included in the wilderness designation. Therefore, much of the stabilization effort in this zone would not be in the wilderness area of the park. However, some actions taken to stabilize the steep slopes in zone 1A may involve the use of adjacent wilderness areas to access the zone, and actions taken in zone 1A would indirectly affect adjacent wilderness.

Restoration Actions in Zones 1B through 4

Alternative B would emphasize a smaller scale of management activity, compared with the other action alternatives, to restore portions of the impacted area. This alternative would focus actions on areas that are unstable and present a high potential of continued degradation of existing ecosystem resources and services. Management activities would be conducted using hand tools that include shovels, pickaxes, chainsaws, etc. Small amounts of debris and sediments would be redistributed to reduce erosion and stabilize areas with very steep slopes along approximately 1,100 feet in zone 1 B, zone 2 along Lulu Creek, and in zone 3 along the Colorado River. Approximately 6 acres in Zones 1B, 2, and 3 would be seeded. Restoration activities in zone 4 would be limited to repair and stabilization of channel headcuts and approximately 1.5 acres would be planted with wetland turf or sedge sprigs. Under this alternative, there would be no active management to change the hydrologic conditions, and the National Park Service would instead rely upon natural processes to restore the hydrologic channel stability condition in the stream channels and wetland areas. Under this alternative, the rate of hydrologic and ecological recovery would increase compared to alternative A as nearly 50% of the restoration goals would be met within 100 years. Figures 2.10 though 2.14 in the environmental impact statement depict the areas to be treated within each zone.

Crews, supplies, and hand tools would be brought into the wilderness by trucks using the Grand Ditch roadway which occurs outside of wilderness. Additionally, supplies may be delivered to work crews by pack animals. In zone 1A, during stabilization of the hillside, trucks and additional equipment would be mobilized along the Grand Ditch Road outside of the wilderness boundary. For stabilization actions within zone 1A some heavy equipment would be helicoptered in over the wilderness area at the beginning of the construction phase and flown out upon completion. A temporary camp for crews would be staged in an upland area in the vicinity of Dutch Creek. It is expected that the actions under alternative B would take up to two years to complete.

Effects:

Wilderness Character

"Untrammeled" – While zone 1A does not fall within the wilderness boundary, construction of option 1 or 2 would be evident from the wilderness area and some activity would occur on the wilderness boundary. Trucks and additional equipment would be mobilized along the Grand Ditch Road outside of the wilderness boundary. While this zone is being stabilized, the visibility of human manipulation would have a short-term adverse impact on the untrammeled character of the adjacent wilderness. Once installed, stabilization under option 1 or 2 would allow for some revegetation of the slope. However, the stabilized slope would not look significantly different than the surrounding steep and sparsely vegetated slopes which are remnants of construction of the Grand Ditch. As a result, long-term benefits to the untrammeled wilderness character would be slight.

Under alternative B, soil erosion and sedimentation in wilderness would be reduced; however, there would continue to be evidence of human caused alteration of the wilderness with the existence of the gully in zone 1B, the alluvial fan in zone 2, and the homogeneous sedge wetland and sheet flow in zone 4. Because revegetation and stabilization would only occur in spot locations in zones 1B through 4 under alternative B, full recovery of the habitat and community functions would still take up to 200 years and some damages would remain permanent. Collectively, there would be a small level of benefit over the long-term, to the untrammeled wilderness character from revegetation and stabilization relative to alternative A.

Human manipulation from implementation of these small scale restoration actions would result in short-term adverse impacts to the untrammeled wilderness character.

"Undeveloped" – Stabilization of zone 1A under both option 1 and 2 would require the use of trucks and additional equipment that would be mobilized along the Grand Ditch Road and used within zone 1A, outside of and along the wilderness boundary. While this zone is being stabilized, the presence of equipment and machinery would have a short-term adverse impact on the undeveloped character of the adjacent wilderness.

During implementation, a temporary line camp would be established within zone 3 near Dutch Creek. This line camp would temporarily house restoration workers within the wilderness area and would consist of sleeping tents, a kitchen tent, and bathroom facilities that would be removed after restoration activities were complete. Additionally, some mitigation measures, such as silt fences would be installed during restoration implementation. These disturbed areas would be restored to reflect pre-disturbance conditions. Collectively, these temporary developments would result in localized short-term adverse impacts to the undeveloped wilderness character.

"Natural" – In zone 1A, the hillside would be stabilized preventing erosion into the project area. During and after construction, the National Park Service would require the use of mitigation measures to prevent erosion. In the long-term, erosion and downstream sedimentation from zone 1A would be reduced resulting in a low level of benefits.

Under alternative B, revegetation and stabilization would occur in very steep areas. However, the gully in zone 1B and the alluvial fan in zone 2 would continue to erode and contribute to downstream sedimentation and degradation of water quality. In zone 4, bare areas would be revegetated with wetland turf or sedge sprigs and would reduce the potential for erosion of debris in localized areas, but sediment would remain in place and the Colorado River would continue to be unnaturally restricted to the western side of the wetland. The natural quality of the wilderness would continue to be impacted by the resulting homogenous vegetation and sheet flow conditions present in the wetland.

Because revegetation and stabilization would only occur in spot locations in zones 1B through 4 under alternative B, full recovery of the habitat and community functions would still take up to 200 years. Hydrologic and ecological processes would continue to be impacted by sediment deposits and erosion. However, there would be localized recovery of vegetation within the project area. Collectively, small level long-term benefits to the natural wilderness quality from revegetation and stabilization would result relative to alternative A.

Short-term, adverse impacts would result from the following: preparation of soil for seeding, the presence of erosion control mats, the presence of temporary work camps, disturbance of surface waters during bank stabilization, and the use of mitigating measures.

"Outstanding opportunities for solitude or a primitive and unconfined type of recreation" – Once installed, stabilization under option 1 or 2 in zone 1A would allow for some revegetation of the slope. However, the stabilized slope would not look significantly different than the sparsely vegetated surrounding slopes and would still be visible from much of the Kawuneeche Valley. As a result, the long-term impacts on opportunities for solitude or primitive and unconfined recreation would be slight and beneficial compared with alternative A. While most of the debris from the breach would remain in place, over the long-term revegetation and stabilization along the banks throughout the project area would reduce the visual evidence and continuing impacts from the damages caused by the breach. The reduced visual impacts would result in beneficial impacts to opportunities for solitude or primitive and unconfined recreation.

Under alternative B, restoration implementation would start in the late spring and extend until early fall, the time of year when visitor use is highest in and around the project area. High levels of intrusions to the quality of solitude would occur from the visual presence of work crews, temporary line camps, and the intrusions of human voices, hand tools, and infrequent helicopter overflights to the natural soundscape. These intrusions would result in short-term impacts to opportunities for solitude or primitive and unconfined recreation.

During implementation, the dispersed backcountry campsites in proximity to the project area and portions of the Colorado River and Thunder Pass Trails may be temporarily closed for a short time. Alternate routes would continue to provide access to the wilderness area within the Kawuneeche Valley. Temporary closure of the trails would result in highly localized short-term impacts to opportunities for primitive and unconfined recreation.

Additionally, education and interpretation under alternative B would inform visitors of the ecological and hydrologic impacts from the 2003 breach and improve visitor understanding of the intentions and anticipated results of restoration. This increased understanding of the project area and how each wilderness quality has and would be affected would result in short and long-term beneficial impacts to opportunities for solitude or primitive and unconfined recreation.

Other unique components that reflect the character of this wilderness – NA

Heritage and Cultural Resources – Ground disturbance from revegetation activities would be minimal and would not take place in locations of known archeological resources, i.e. – the Lulu City site or its associated wagon roads. There would be negligible effects on archeological resources within the wilderness.

Maintaining Traditional Skills – The emphasis on use of hand tools including crosscut saws, picks, shovels, hand powered winches, and stock for resupply contributes to the maintenance of traditional skills.

Special Provisions – None identified.

Economics and Timing Constraints – Due to high stream flow conditions in the spring and significant snowfall that occurs in the fall, restoration activities would generally take place from June 15 through September 15, over the course of two years. Given the use of strictly man-power and hand tools to stabilize and revegetate the disturbed area, this alternative would accomplish a low level of restoration compared to other alternatives. To accomplish a larger scale of restoration by use of crews with hand tools would be extremely difficult and dangerous given the large scale of debris deposits in the form of trees and boulders that would need to be moved and used to stabilize banks and enhance hydrologic conditions. In addition, it would take an extraordinary amount of time using only hand tools to accomplish the level of restoration considered in other action alternatives. During the extensive time period, on-going natural processes such as annual high-flow erosion and sedimentation would over-take and counteract the results of restoration activities. The cost to implement this alternative would be approximately $4.1 million as a result of transport of equipment by helicopter to stabilize zone 1A and the labor costs associated with multiple crews performing restoration activities.

Additional Wilderness-specific Comparison Criteria – None identified.

Safety of Visitors, Personnel, and Contractors – There are inherent risks associated with work in the rugged terrain of the backcountry and in wilderness. There would be safety risks involved with the use of hand tools such as spades, pickaxes, and saws including chainsaws. Two or three crews made up of five-person teams would work in 10 day shifts to conduct the work. Transporting equipment and moving debris for stabilization of stream banks would entail safety risks. Access to trails by visitors within the work areas would be restricted while activities were occurring so there would be no risk to the public.
Due to the large amount of debris that would remain within the impacted area, safety risks to visitors and park staff would occur from the potential for high spring flows to mobilize sediment and debris that could wash out bridges and trails within the area.

Alternative C

Description:

Stabilization of Zone 1A:
Stabilization of zone 1A using option 1 or option 2 would be the same as described for alternative B.

Restoration Actions in Zones 1B through 4
This alternative would involve more intensive management actions over large portions of the impacted area. This alternative would focus actions on areas that are unstable and present a high to moderate potential of continued degradation of existing ecosystem resources and services. Restoration methods would be used to stabilize banks, slopes, and disturbed areas; to improve channel stability in portions of Lulu Creek and the Colorado River; and to reduce sediment transport over a larger portion of the project area. To reduce sediment transport, a portion of the alluvial fan in zone 2 would be removed and the excavated debris would be used to create terraces in a 0.5 acre upland area adjacent to the Lulu Creek. This alternative would also actively restore the hydrologic conditions in large portions of the impacted area by removing sediment from the 2003 breach or the equivalent, constructing and enhancing step pools, reconnecting the Colorado River with the floodplain in localized areas, and restoring the Colorado River to the historic central alignment through the wetland. A berm or barrier, approximately 5,000 square feet, would be created out of cobbles, boulders, and debris excavated from zone 4, at the upstream end of the wetland to direct river flow to the historic central alignment. This berm would be constructed so that it blends with existing physical setting, planted with trees, shrubs, and grasses so that it would appear as a natural landform. Debris excavated from Lulu City Wetland would be deposited in an upland area in the vicinity of Dutch Creek. The debris terraces would be contoured to reflect old glaciated features that were created during the last ice age and should be unnoticeable in the future. Under this alternative, approximately 19 acres within wilderness would be affected, with approximately 10,000 feet of stream channel modifications, and 84,000 cubic yards of debris excavated and stored.

Active measures would be taken to plant and protect willow communities in some locations in zones 3 and 4 using approximately 7,095 linear feet of exclosure fencing material. Browsing exclosures would remain in place until the plants reached approximately 8 feet in height and were able to withstand browsing pressure, (assumed to take approximately 15-20 years). Following this time, the browsing exclosures would be removed.

Under this alternative, the rate of hydrologic and ecological recovery would increase compared to alternative B as nearly 80% of the restoration goals would be met within 100 years. Figures 2.15 though 2.19 in the environmental impact statement depict the areas to be treated within each zone.

This alternative would involve the use of heavy equipment and possibly reusing excavated debris for restoration and stabilization actions both within and between zones. Helicopters would be used to transport equipment into the project area at the beginning of the project and remove the equipment when restoration activities were complete. Recontouring would be done using small mechanized equipment such as small tillers and blades; shovels and rakes; compactors; and hand tools to flatten banks and firm the disturbed soil to make it suitable for plant growth. Mechanized equipment expected to be used in the restoration activities would include, but not be limited to, “walking” excavators, front end loaders, bulldozers, graders, dump trucks, and water trucks. Some of this equipment would need to be specialized for use in very steep areas and in muddy and highly saturated areas where groundwater is near the surface. Temporary channels or by-pass pipes may be required to re-route Colorado River flows while work was underway to stabilize weak sections of the channel or to excavate the old river meander. Any of these methods would be temporary in nature and would be dismantled and removed after implementation of the restoration activity.

Effects:

Wilderness Character

“Untrammeled” – Impacts to the untrammeled wilderness quality from stabilization of the hillside within zone 1A would be the same as those described under alternative B. Option 1 and 2 would result in slight long-term benefits to the untrammeled wilderness character.

Over the long-term, the restoration actions would reduce the damages caused by the 2003 breach. Evidence of the 2003 breach would be reduced from recontouring and stabilization of undercut slopes and revegetation. Braided channels would be reconfigured to single channels, reflecting pre-breach conditions. Some debris would be removed from the alluvial fan and used to create terraces in an area northeast of the fan. However, some sediment within the main stream channel and the alluvial fan would remain and would continue to erode and disturb the wilderness character by evidencing human caused degradation. Wetland areas in zones 3 and 4 would be enhanced and improved by re-establishing connectivity with the Colorado River to better reflect ecological reference conditions. The hydrologic conditions in the wetland in zone 4 would be actively restored to support a tall willow complex. Revegetation of bare areas, filling of the western channel, and placement of boulders in highly erosive areas of zone 4 would collectively restore damages caused by the breach.

Collectively, there would be a high level of benefit to the untrammeled wilderness quality over the long-term, relative to alternative A. However, the creation of terraces in zone 2 and 3 to accommodate excavated debris would impact areas that were previously undisturbed. While these terraces would be revegetated, their presence would detract from the untrammeled wilderness character.

Implementation of restoration actions would require phasing, mitigation measures, and the use of heavy machinery. Collectively, the human manipulation from implementation of these large-scale restoration actions would diminish the untrammeled wilderness character in the short-term.

"Undeveloped" – Impacts to the undeveloped wilderness quality from stabilization in zone 1A would be the same as described under alternative B. Under alternative C, mechanized equipment would also be used throughout zones 1B through 4. The presence of this equipment and machinery would have a short-term adverse impact on the undeveloped character of the wilderness.

During restoration implementation, a temporary line camp and staging area would be established as described under alternative B. Due to the more extensive restoration activities under alternative C, more workers may be required and the line camp would be sized to accommodate the increase. Mitigation measures, such as silt fences would be installed during implementation of the restoration. These disturbed areas would be restored to reflect pre-disturbance conditions after restoration actions were complete. Temporary mitigation developments would result in, highly localized, short-term, adverse impacts to the undeveloped wilderness quality.

Additionally, browsing exclosures would be installed around willow planting areas in zone 3 and 4 in order to protect the vegetation from elk and other browsing ungulates. Fences would remain in place for approximately 15 to 20 years. While these exclosures would be removed from the wilderness area, while in place they would result in long-term, localized adverse impacts to the undeveloped wilderness quality.

Temporary channels or by-pass pipes may be installed to re-route Colorado River flows while work to stabilize weak sections of the channel was taking place. These channels or pipes would remain in position while restoration to the river channel was taking place and would be removed once this activity was complete. During implementation, they would result in short-term localized adverse impacts to the undeveloped wilderness quality.

"Natural" – A small degree of benefit to the natural wilderness quality from stabilization of the hillside in zone 1A would be the same as those described under alternative B.

Under alternative C, hydrologic and ecological conditions would be restored to a high degree. Revegetation, reestablishment of a single channel through multiple braided areas, bank stabilization, and removal of debris would reduce downstream erosion and aggradation, improving water quality, aquatic habitat, and enhancing overall stream conditions both within and downstream of the project area. Some debris would be removed from the alluvial fan; however, debris remaining in the channel would continue to alter habitat and water quality in Lulu Creek and the Colorado River. Wetland areas in zones 3 and 4 would be enhanced and improved by re-establishing connectivity with the Colorado River to better reflect ecological reference conditions. The hydrologic conditions in the wetland in zone 4 would be actively restored to be suitable to support a tall willow complex, consistent with natural reference conditions.

Revegetation of bare areas, filling of the western channel, and placement of boulders in highly erosive areas of zone 4 would collectively restore natural conditions to a large degree.

Collectively, during implementation, short-term, adverse impacts to the natural wilderness quality would result from the following:

- Preparation of soil for seeding;
- The presence of erosion control mats;
- The presence of temporary line camps;
- Disturbance of surface waters during bank stabilization;
- Disturbance and sedimentation during excavation and channel reconfiguration of Lulu Creek and the Colorado River;
- The creation of debris terraces; and
- The use of mitigating measures.

Over the long-term, the rate of hydrologic and vegetative recovery would increase and ecological and hydrologic processes would improve as a result of restoration activities. Collectively, there would be a high level of benefit to the natural wilderness quality relative to alternative A.

"Outstanding opportunities for solitude or a primitive and unconfined type of recreation" – Long-term impacts from stabilization of zone 1A under option 1 or 2 would be the same as described under alternative B. The use of temporary browsing exclosures around willow plantings, terraces established in previously undisturbed areas, and a diversion berm would add additional visual intrusion that would impact the primitive quality of the wilderness. These intrusions would diminish the opportunities for solitude or primitive and unconfined recreation to a high degree in both the short and long-term; however, over time these features would be less obvious as vegetation and stream process would result in a blending of these features with the surrounding natural environment. Over the long-term, restoration actions under alternative C throughout the project area would greatly reduce the visual evidence and continuing impacts from the damage caused by the breach. The reduced visual impacts would result in long-term, beneficial impacts to opportunities for solitude or primitive and unconfined recreation.

As under alternative B, restoration implementation would start in the late spring and extend until early fall over the course of two years. Under alternative C, mechanized equipment would be used to implement restoration activities and helicopters would be used to fly equipment into zone 1A and the wilderness portion of the project area. Additionally, 15 to 20 years following restoration implementation, removal of the browsing exclosures would require the use of heavy machinery over the course of several days. The visual presence and noise of mechanized equipment in and adjacent to the wilderness area would diminish to a high degree the opportunities for solitude and the primitive wilderness character in localized areas.

During implementation, the dispersed backcountry campsites and portions of the Colorado River and Thunder Pass Trails would be closed for a short time. Closures would be phased and alternate routes would continue to provide access to the wilderness area within the Kawuneeche Valley. Closure of the trails and campsites would result in localized, short-term, adverse impacts to opportunities for primitive and unconfined recreation.

Impacts from education and interpretation provided under alternative C would be the same as described under alternative B.

Other unique components that reflect the character of this wilderness – Not Applicable.

Heritage and Cultural Resources –Slight adverse impacts to these resources would be the same as described under alternative B.

Maintaining Traditional Skills – Not applicable.

Special Provisions – None identified.

Economics and Timing Constraints – Due to high stream flow conditions in the spring and significant snowfall that occurs in the fall, restoration activities would generally take place from June 15 through September 15 over the course of two years. The cost to implement this alternative would be approximately $11.2 million because of the increased use of mechanized equipment and transport of large scale construction equipment to the project area.

Additional Wilderness-specific Comparison Criteria – None identified.

Safety of Visitors, Personnel, and Contractors – There are inherent risks associated with work in the rugged terrain of the backcountry and in wilderness. There would be safety risks involved with the use of hand tools such as spades, pickaxes, and saws including chainsaws. There would be increased risk to contractor safety with the use of large-scale machinery compared to alternative B. With increased reliance on larger machinery, there would be fewer field staff involved in moving large debris for stabilization of stream banks and steep slopes which would decrease some safety concerns compared to alternative B. Access to trails by visitors within the work areas would be restricted while activities were occurring so there would be no risk to the public.

Alternative D, Preferred

Description:

Stabilization of Zone 1A:
Option 1 would be implemented to stabilize the hillside in zone 1A as described for alternative B.

Restoration Actions in Zones 1B through 4
This alternative would emphasize the removal of large debris deposits in the alluvial fan area of zone 2 and in the Lulu City wetland in zone 4. Actions would be conducted to provide stabilization of limited areas of unstable slopes and banks. In zones 1B, 2, and 3 localized stabilization actions would be implemented in areas with steep slopes, where vegetation has not re-established since the breach event. These areas are outside of the channel and floodplain and therefore are not exposed to normal high flows. Actions would be taken to remove selected debris deposits to enhance hydrologic conditions and to remove debris sources that could be eroded and transported downstream. The debris deposited in the alluvial fan would be removed; sediment would be removed in localized areas along the Colorado River to reconnect the river with previously blocked floodplain locations; and sediment from the 2003 breach event would be removed, to a large degree, from the Lulu City wetland. The excavated debris would be used to create terraces in upland areas away from the stream. These terraces would be contoured to reflect old glaciated features that were created during the last ice age and should be unnoticeable in the future. Hydrology through the Lulu City wetland would be restored through the historic central channel through removal of large deposits of debris. Under this alternative, approximately 19 acres within wilderness would be affected, with approximately 7,500 feet of stream channel modifications, and 75,000 cubic yards of debris excavated and stored.

Active measures would be taken to plant and protect willow communities in some locations in zones 3 and 4 using approximately 2,375 linear feet of exclosure fencing material. Browsing exclosures would remain in place until the plants reached approximately 8 feet in height and were able to withstand browsing pressure, (assumed to take approximately 15-20 years). Following this time, the browsing exclosures would be removed.

Under this alternative, the rate of hydrologic and ecological recovery would increase compared to alternatives B and C as nearly 90% of the restoration goals would be met within 100 years. Figures 2.20 though 2.24 in the environmental impact statement depict the areas to be treated within each zone.

Helicopters would be used to transport equipment into the project area at the beginning of the project and remove the equipment when restoration activities were complete. Revegetation and spot stabilization would be done using small mechanized equipment such as small tillers and blades; shovels and rakes; compactors; and hand tools to flatten banks and compact the disturbed soil. A "walking" excavator would be used to reshape and stabilize more difficult slopes. Most of the recontouring and excavation work completed in zone 4 and in the alluvial fan area of zone 2 would be accomplished with large earth-moving equipment such as "walking" excavators, backhoes and front end loaders. Some of this equipment would need to be specialized for use in very steep areas and in muddy and highly saturated areas where groundwater is near the surface. Temporary channels or by-pass pipes may be required to re-route Colorado River flows while work was underway to stabilize weak sections of the channel or to excavate the old river meander. All of these methods would be temporary in nature and would be dismantled and removed after implementation of the restoration activity.

Effects:

Wilderness Character

"Untrammeled" – There would be low level benefits to the untrammeled wilderness quality from stabilization using option 1 in zone 1A as described under alternative B.

Over the long-term, the restoration actions would reduce the damages caused by the 2003 breach. Revegetation and recontouring of localized areas within the stream channels would occur in zones 1B and 2; however, the steep gully in zone 1B and the braided channels would remain and would continue to degrade the untrammeled nature of the wilderness. The alluvial fan would be removed and a single channel established reflective of pre-breach conditions. Wetland areas in zones 3 and 4 would be enhanced and improved by re-establishing connectivity with the Colorado River to better reflect ecological reference conditions. Debris berms would be excavated to allow the main channel of the Colorado River to return to the old oxbow at the head of the wetland and into the historic central channel. The hydrologic conditions in the wetland in zone 4 would be actively restored to support a tall willow complex. Removal of the 2003 (or equivalent) debris from the western side of the wetland, revegetation of bare areas with willows, sedges, and hydric grasses and placement of boulders along the banks would collectively restore damages caused by the 2003 breach.

Collectively, restoration actions would result in a high level of long-term benefits to the untrammeled wilderness quality relative to alternative A. However, damages from the 2003 breach would remain in zone 1B and the upper portions of zone 2 and the creation of terraces in zone 2 and 3 to accommodate debris removed from both the wetland and the alluvial fan would impact areas that were previously undisturbed.

Implementation of the restoration actions would require phasing, mitigation measures, and the use of heavy machinery. Collectively, human manipulation from implementation of these restoration actions would diminish the untrammeled wilderness character to a high level over a short-period of time.

"Undeveloped" – Impacts to the undeveloped wilderness quality from the presence of equipment and machinery in zones 1A through 4 would be the same as described in alternative C.

The adverse effects to the undeveloped wilderness quality as a result of a temporary line camp, staging areas, mitigation measures, browsing exclosures, and temporary channels or by-pass pipes would be as described in alternative C.

"Natural" – A small level of long-term benefit to the natural wilderness quality would result from stabilization of the hillside in zone 1A through implementation of option 1 as described under alternative B.

Under alternative D, hydrologic and ecological conditions would be restored to a high degree. Revegetation and recontouring of steep slopes in localized areas of zones 1B and 2 would reduce erosion and enhance stream conditions. The steep gully would remain and would continue to contribute to small amounts of sedimentation downstream. The removal of the debris from the alluvial fan and restoration of a single channel would reduce erosion substantially. Wetland areas in zones 3 and 4 would be enhanced and improved by re-establishing connectivity with the Colorado River to better reflect ecological reference conditions. Debris berms would be excavated to allow the main channel of the Colorado River to return to the old oxbow at the head of the wetland and into the historic central channel. The hydrologic conditions in the wetland in zone 4 would be actively restored to support a tall willow complex consistent with natural reference conditions. Revegetation of willows in the western portion of the wetland would increase species diversity. Revegetation of sedges and hydric grasses in the central portion of the wetland would reduce erosion.

During implementation, short-term, adverse impacts to the natural wilderness would occur as described under alternative C.

Over the long-term, the rate of hydrologic and vegetative recovery would increase and ecological and hydrologic processes would improve as a result of restoration activities particularly the removal of large amounts of debris. Collectively, there would be a high level of benefit to natural wilderness quality would relative to alternative A.

"Outstanding opportunities for solitude or a primitive and unconfined type of recreation" – A small level of benefit would result to opportunities for solitude or primitive and unconfined recreation from stabilization of the hillside in zone 1A with implementation of option 1 as described under alternative B. A reduction in the long-term visual evidence of damage caused by the 2003 breach would be similar to that described under alternative C. While restoration activities would not be as evident in zone 1B and the upper portions of zone 2 as under alternative C, the removal of debris from the alluvial fan and the

Lulu City wetland and the establishment of tall willows in Lulu City wetland would greatly reduce the evidence of the 2003 breach. The reduced visual impacts and reduced continuing impacts from damages caused by the breach would result in a large level of benefit to opportunities for solitude or primitive and unconfined recreation. However, as under alternative C, the creation of debris terraces in areas that were previously undisturbed and browsing exclosures would detract from the perception of primitive and unconfined recreation and result in long-term adverse effects until revegetation established and the browsing exclosures were removed. Over time these features would be less obvious as vegetation recovery would result in a blending of these features with the surrounding natural environment.

As under alternative B and C, restoration implementation would start in the late spring and extend until early fall over the course of two years. Under alternative D, the use of mechanized equipment and helicopters would be similar to that described under alternative C. The visual presence and noise of mechanized equipment in and adjacent to the wilderness area would have localized short-term, adverse impacts on opportunities for solitude and the primitive wilderness character.

Temporary closures of dispersed backcountry campsites and portions of the Colorado River and Thunder Pass Trails would be similar to those described under alternative C. Closure of the trails and campsites would result in localized, short-term, adverse impacts to opportunities for primitive and unconfined recreation.

Impacts from education and interpretation provided under alternative D would be the same as described under alternative B.

Other unique components that reflect the character of this wilderness – NA

Heritage and Cultural Resources – Slight adverse impacts to these resources would be the same as described under alternative B.

Maintaining Traditional Skills – Not applicable.

Special Provisions – None identified.

Economics and Timing Constraints – Due to high stream flow conditions in the spring and significant snowfall that occurs in the fall, restoration activities would generally take place from June 15 through September 15 over the course of two years. The cost to implement this alternative would be approximately $9.1 million as a result of the increase in mechanized equipment that must be rented or purchased, the transport of large scale construction equipment to the project area, and increased labor cost. .

Additional Wilderness-specific Comparison Criteria – None identified.

Safety of Visitors, Personnel, and Contractors – There are inherent risks associated with work in the rugged terrain of the backcountry and in wilderness. There would be safety risks involved with the use of hand tools such as spades, pickaxes, and saws including chainsaws. There would be increased risk to contractor safety with the use and transport of large-scale machinery compared to alternative B. With increased reliance on larger machinery there would be fewer field staff involved in moving large debris for stabilization of stream banks and steep slopes which would decrease some of the safety concerns compared to alternative B. Access to trails by visitors within the work areas would be restricted while activities were occurring so there would be no risk to the public.

Alternative E

Description:

Stabilization of Zone 1A:
Stabilization of zone 1A would be the same as described for alternative B.

Restoration Actions in Zones 1B through 4
This alternative would involve an extensive level of management activity and use of large-scale mechanized equipment over large portions of the impacted area to restore the project area to reflect both pre-breach and desired historical conditions. Engineered solutions using native materials such as large woody debris and boulders would be used to stabilize banks and slopes to approximate pre-breach contours and to reduce transport of sediments over a larger portion of the impacted area. The debris deposited in the alluvial fan would be removed and sediment would be removed along 860 feet of the Colorado River to reconnect the river with previously blocked floodplain locations. Extensive changes would be made to both the existing and historical Colorado River channels to route the river to its historical alignment through the center of the Lulu City wetland. This alternative would actively restore the hydrologic conditions by removing debris deposits resulting from the 2003 breach and additional historic human-caused deposits. Debris would be reused in the restoration and stabilization actions both within and between zones. The excavated debris would also be used to create terraces in upland areas away from the stream. These terraces would be contoured to reflect old glaciated features that were created during the last ice age and should be unnoticeable in the future. Under this alternative, approximately 37 acres within wilderness would be affected, with approximately 10,000 feet of stream channel modifications, and 176,000 cubic yards of debris excavated and stored.

Active measures would be taken to plant and protect willow communities in some locations in zones 3 and 4 using approximately 8,015 linear feet of exclosure fencing material. Browsing exclosures would remain in place until the plants reached approximately 8 feet in height and were able to withstand browsing pressure, (assumed to take approximately 15-20 years). Following this time, the browsing exclosures would be removed.

Under this alternative, the rate of hydrologic and ecological recovery would increase compared to other alternatives as nearly 95% of the restoration goals would be met within 100 years. Figures 2.25 though 2.29 in the environmental impact statement depict the areas to be treated within each zone.

Recontouring, bank stabilization, and relocation of debris throughout the zone would be done using mechanized equipment such as small tillers and blades, shovels and rakes, compactors, and hand tools to flatten banks and compact the disturbed soil. Mechanized equipment that would be expected to be used in the restoration activities would include, but not be limited to, “walking” excavators, front end loaders, bulldozers, graders, dump trucks, and water trucks. Some of this equipment would need to be specialized for use in very steep areas and in muddy and highly saturated areas where groundwater is near the surface. Temporary channels or by-pass pipes may be required to re-route Colorado River flows while work was underway to stabilize weak sections of the channel or to excavate the old river meander. Any of these methods would be temporary in nature and would be dismantled and removed after implementation of the restoration activity.

Under this alternative, an area would be established as a helicopter landing in the vicinity of Dutch Creek. And due to the large amount of debris to be moved within and between zones, a temporary access and mechanized equipment haul road approximately 0.5 mile (2,900 feet) long and 20 feet wide would be required to move excavated debris from the wetland area to a permanent upland debris disposal area. The disposal area and the haul road would be removed after restoration activities are complete and would be recontoured and planted with trees to blend with the existing landscape.

Effects:

Wilderness Character

"Untrammeled" – Impacts to the untrammeled wilderness quality from stabilization of the hillside within zone 1A would be the same as those described under alternative B. Option 1 and 2 would result in slight long-term benefits to the untrammeled wilderness character.

Under this alternative, restoration actions would be conducted within the project area to reflect ecological reference conditions to the greatest extent possible. The gully that resulted from the breach would be filled and restored to pre-2003 contours in zone 1B. Braided channels would be reconfigured to single channels, reflecting pre-breach conditions. Step pools would be enhanced and/or recreated and banks would be stabilized through recontouring in zones 2 and 3. The debris within the alluvial fan would be removed and used to create terraces in an area northeast of the fan. The alluvial fan and the newly created terraces would be revegetated with upland species. Wetland areas in zones 3 and 4 would be enhanced and improved by re-establishing connectivity with the Colorado River to better reflect ecological reference conditions. In zone 4, excavation of debris berms to allow the main channel of the Colorado River to return to the old oxbow at the head of the wetland and into the historic central channel would restore hydrologic conditions. Removal of the 2003 and historic debris from the western side of the wetland and filling of the western channel would create conditions suitable for native tall willow, consistent with natural reference conditions. Revegetation of bare areas with willows and placement of boulders along the banks would increase stabilization and reduce erosion. These actions would greatly reduce the damages caused by the 2003 breach.

Over the long-term, the restoration actions under alternative E would greatly reduce erosion and restore damages caused by the 2003 breach. Collectively, there would be large scale benefits to the untrammeled wilderness quality relative to alternative A. However, the creation of terraces in zones 2 and 3 to accommodate debris removed from both the wetland and the alluvial fan would impact areas that were previously undisturbed. While these terraces would be revegetated, they would diminish the untrammeled wilderness character in the short and long-term.

Implementation of the restoration actions would require phasing, mitigation measures, the use of heavy machinery, and construction of a debris haul road through zone 3. Collectively, over the short-term the human manipulation from implementation of these restoration actions would diminish the untrammeled wilderness character of the area to a high degree.

"Undeveloped" – Impacts to the undeveloped wilderness quality from the presence of equipment and machinery in zones 1A through 4 would be the same as described in alternative C.

The adverse effects to the undeveloped wilderness quality as a result of a temporary line camp, staging areas, mitigation measures, browsing exclosures, and temporary channels or by-pass pipes would be as described in alternative C.

During restoration, a temporary haul road would be constructed through zone 3 in order to transport and relocate debris removed from zone 4. Construction of a temporary haul road during restoration would diminish the undeveloped wilderness character to a high degree in the short-term.

"Natural" – A small degree of benefit to the natural wilderness quality from stabilization of the hillside in zone 1A would be the same as those described under alternative B.

Under alternative E, hydrologic and ecological conditions would be restored to reflect ecological reference conditions to the greatest extent. The gully that resulted from the breach would be filled and restored to pre-2003 contours in zone 1B. Braided channels would be reconfigured to single channels, reflecting pre-breach conditions. Step pools would be enhanced and/or recreated and banks stabilized through recontouring in zones 2 and 3. The debris within the alluvial fan would be removed and used to create terraces in an area northeast of the fan. The alluvial fan and the newly created terraces would be revegetated with upland species. Wetland areas in zones 3 and 4 would be enhanced and improved by re-establishing connectivity with the Colorado River to better reflect ecological reference conditions. In zone 4, excavation of debris berms to allow the main channel of the Colorado River to return to the old oxbow at the head of the wetland and into the historic central channel would restore hydrologic conditions. Removal of the 2003 and historic debris from the western side of the wetland and filling of the western channel would create conditions suitable for native tall willow consistent with natural reference conditions. Revegetation of willows in the western and central portions of the wetland would increase species diversity and reduce downstream sedimentation. The removal of the historic debris would result in more stable hydrologic conditions.

Collectively, during implementation, short-term impact to the natural wilderness quality from the restoration would be the same as described under alternative D. However, under alternative E, construction of a temporary haul road and the use of additional debris storage areas would increase adverse impacts.

Over the long-term, the rate of hydrologic and vegetative recovery would increase and ecological and hydrologic processes would be restored as a result of restoration activities. This would benefit the natural wilderness quality to a high level relative to alternative A.

"Outstanding opportunities for solitude or a primitive and unconfined type of recreation" – Long-term impacts from stabilization of zone 1A under option 1 or 2 would be the same as described under alternative B. The use of temporary browsing exclosures around willow plantings, terraces established in previously undisturbed areas, and creation of a temporary haul road would add additional visual intrusion that would detract from the primitive quality of the wilderness. Over time, the browsing exclosures and terraces would be less obvious as vegetation would result in a blending of these features with the surrounding natural environment. In addition, the haul road would be restored after restoration activities were complete. Over the long-term, the removal of the alluvial fan, debris removal, and establishment of tall willows in Lulu City wetland would greatly reduce the evidence and continuing impacts from the 2003 breach. The reduced visual impacts would result in substantial beneficial effects on opportunities for solitude or primitive and unconfined recreation.

As under alternative B, C, and D, restoration implementation would start in the late spring and extend until early fall. However, alternative E restoration would take place over the course of two to three years. The use of mechanized equipment and helicopters would be similar to that described under alternative C. However, under alternative E, the use of mechanized equipment would be prolonged due to the increased amount of debris being removed from zone 4. Additionally, the removal of browsing exclosures would be the same as described under alternative C, 10 to 15 years following restoration implementation. The visual presence and noise of mechanized equipment in and adjacent to the wilderness area would diminish opportunities for solitude and the primitive wilderness character to a high degree the over the short-term.

Temporary closures of dispersed backcountry campsites and portions of the Colorado River and Thunder Pass Trails would be similar to those described under alternative C. The removal of additional debris in zone 4 and the potential for an additional season to complete the restoration would result in prolonged closures of trails and/or campsites. Closure of the trails and campsites would result in localized, short-term, adverse impacts to opportunities for primitive and unconfined recreation.

Impacts from education and interpretation provided under alternative C would be the same as described under alternative B.

Other unique components that reflect the character of this wilderness – NA

Heritage and Cultural Resources – Impacts to the historic Lulu City site would be the same as described for alternative B. However, the former wagon road which now exists as the Colorado River/Lulu City Trail would be crossed by a staging /haul road for heavy restoration equipment. Remnants of the wagon wheel ruts may potentially fall within the area of the proposed road where it overlaps with the trail. Protective measures would be installed, such as temporary bridging or metal tracking, to avoid impacts to any visible remnants of the wagon trail. With mitigation, slight impacts to cultural resources would be long-term and adverse.

Maintaining Traditional Skills – Not applicable.

Special Provisions – None identified.

Economics and Timing Constraints – Due to high stream flow conditions in the spring and significant snowfall that occurs in the fall, restoration activities would generally take place from June 15 through September 15 over the course of two to three years. The cost to implement this alternative would be approximately $17.1 million as a result of the large increase in use of mechanized equipment and transport of large scale construction equipment to the project area.

Additional Wilderness-specific Comparison Criteria – None identified.

Safety of Visitors, Personnel, and Contractors – There are inherent risks associated with work in the rugged terrain of the backcountry and in wilderness. There would be safety risks involved with the use of hand tools such as spades, pickaxes, and saws including chainsaws. There would be increased risk to contractor safety with the use of large-scale machinery compared to alternative B. With increased reliance on larger machinery there would be fewer field staff involved in moving large debris for stabilization of stream banks and steep slopes decreasing some of the safety concerns compared to alternative B. Access to trails by visitors within the work areas would be restricted while activities were occurring so there would be no risk to the public.

Step 2 Decision: What is the <u>Minimum</u> Activity?

Please refer to the accompanying MRDG *Instructions* before describing the selected alternative and describing the rationale for selection.

Selected alternative:

Alternative D

<u>Rationale</u> for selecting this alternative (including safety criterion, if appropriate):

This alternative allows the National Park Service to achieve ecological reference conditions that would reflect ecological reference conditions to a large degree. This alternative would employ the use of small and large mechanized equipment which would result in a high level of adverse short-term impact to wilderness qualities and to downstream water quality. However it would result in a high degree of restoration over the entire project area, allow faster recovery of the ecologic and hydrologic systems, and restore the natural and untrammeled character of the wilderness to a high level. Alternative D would rely on the reuse of natural materials to stabilize steep banks and remove large amounts of debris deposits, including the complete removal of the alluvial fan which would greatly reduce erosion, reduce the degradation of wilderness qualities, and protect long term downstream water quality. This alternative would provide for large areas of wetlands to be restored to support tall willow complexes which reflect natural conditions to a greater degree and provide for improved wildlife habitat and ecological services. Browsing exclosures and terraces would detract from the natural quality of wilderness for 15 to 20 years; however the benefits of restoring natural wetland habitats would outweigh these costs. Pre-breach natural and untrammeled conditions would be achieved to a large degree in the Lulu City wetland by restoring the Colorado River alignment to the historic central channel using natural forces, as opposed to constructed berms. This restoration would take place without the wide scale excavation of debris as proposed under alternative E. This restoration would be completed with less adverse impact on the wetland and adjacent areas as it would not require the construction of temporary roads. Using a mixture of small and large scale equipment would allow for a broader level of restoration in the project area, over a short period of time, and with less cost compared to other alternatives. Limiting the amount of staff and time to perform a high level of restoration in rugged terrain also reduces the safety risks to workers. This alternative was identified through a Choosing By Advantages workshop conducted by the park interdisciplinary team in March of 2011 and during a follow-up meeting in May of 2011. This workshop and follow-up meeting compared the short and long-term advantages to wilderness character for each alternative and alternative D was determined to provide the greatest advantage.

Monitoring and reporting requirements: The following components would be monitored during and following implementation of alternative D.

1. Restoration Effectiveness (Success)
    a. Sedges and other herbaceous plants
        i. Establish permanent plots and monitor
            1. Survival by species over time
            2. Spread of clonal plants using small plots which monitor number of shoots of species
            3. Percent cover of all species (by species)
            4. Seed rain/seed transport into the plots
            5. Establishment of species that were not planted
    b. Willow and other woody plants
        i. Survival of the plantings
        ii. Increase in number of live stemson willows
        iii. Willow seed rain into plots
        iv. Height of woody plants for tagged individuals
        v. Herbivory in plots

2. Hydrology
    a. Ground water/surface interactions.
        i. Stream staff gauges and ground water monitoring wells in plots to be measured
        ii. Use of loggers in these sites and work to understand how stream and ground water levels covary.
3. Stream Channel
    a. Stream morphology
        i. Cross sectional measurements of stream channel geometry
            1. Width, depth, step height, and spacing, channel gradient, in –stream wood
            2. Compare to geometry measurements of reference reaches
        ii. Stream flow rates
            1. Relative to bankfull and highest flow on record (2011)
    b. Sediment Transport and Bed Material
        i. Sediment supply vs. capacity analysis for bedload (Soar and Thorne, 2001) on CO river at all gage stations, and historical channel through wetland
        ii. Pebble counts at each gaging station compared to reference reaches
    c. Turbidity
        i. Suspended sediment concentrations

Check any Wilderness Act Section 4(c) uses approved in this alternative:

- ☒ mechanical transport
- ☒ motorized equipment
- ☒ motor vehicles
- ☐ motorboats
- ☒ landing of aircraft
- ☐ temporary road
- ☒ structure or installation (temporary browsing exclosures)

Record and report any authorizations of Wilderness Act Section 4(c) uses according to agency procedures.

Approvals	Signature	Name	Position	Date
Prepared by:	GRAND DITCH EIS Interdisciplinary Team			
Recommended:	David Pettebone	David Pettebone	Wilderness Coordinator	3/13/2013
Recommended:	Ben Bobowski	Ben Bobowski	Chief of Resource Stewardship	4/1/2013
Approved:	Vaughn Baker	Vaughn Baker	Supt	4/8/13

APPENDIX G: STREAM CLASSIFICATION AND NUMERIC STANDARDS FOR WATER QUALITY PARAMETERS

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STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION:12 BASIN: **Upper Colorado River**		Desig	Classifications	NUMERIC STANDARDS						TEMPORARY MODIFICATIONS AND QUALIFIERS
	Stream Segment Description			PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			
1.	Mainstem of the Colorado River, including all tributaries and wetlands, within Rocky Mountain National Park, or which flow into Rocky Mountain National Park.	OW	Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-I)°C D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrIII(ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	
2.	Mainstem of the Colorado River, including all tributaries and wetlands within, or flowing into Arapahoe National Recreation Area.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-I)°C D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrIII(ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	
3.	Mainstem of the Colorado River from the outlet of Lake Granby to the confluence with Roaring Fork River.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-II)°C D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	
4.	All tributaries to the Colorado River, including all wetlands, from the outlet of Lake Granby to the confluence with the Roaring Fork River, which are on National Forest lands, except for those tributaries included in Segments 1 and 2, and specific listings in Segments 8, 9 and 10a.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-I)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
5.	All lakes and reservoirs tributary to the Colorado River from the boundary of Rocky Mountain National Park and Arapahoe National Recreation Area to a point immediately below the confluence with the Roaring Fork River which are not on National Forest lands, except for specific listing in Segments 11 and 12.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CL,CLL)°C Wolford Mtn Res April-Dec $T_{(WAT)}$=19.73°C Williams Fork Res April-Dec $T_{(WAT)}$=21.55°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
6a.	All tributaries to the Colorado River, including all wetlands, from the source to a point immediately above the confluence with the Blue River and Muddy Creek, which are not on National Forest lands, except for specific listings in Segments 1, 2, 4, 5, 6b, 6c, 8, 9 and 10a-c.		Aq Life Cold 1 Recreation P Water Supply Agriculture	T=TVS(CS-I)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 NO_2=0.05 B=0.75 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrIII(ch)=TVS CrVI(ac/ch)=TVS	Cu(ac/ch)=TVS Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS)	Hg(ch)=0.01(tot Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
6b.	Mainstem of un-named tributary from the headwaters (Sec 32, T3N, R76W) to Willow Creek Reservoir Road (Section 8, T2N, R76W).		Aq Life Cold 2 Recreation N Agriculture	T=TVS(CS-II)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	CN(ac)=0.2	S=0.002 B=0.75 NO_2=0.05 NO_3=100	As(ac)=340(dis) As(ch)=100 Cd(ch)=10 CrIII(ch)=100 CrVI(ch)=100	Cu(ac)=200 Pb(ch)=100 Mn(ch)=200 Ni(ac/ch)=200	Se(ch)=20 Zn(ch)=2000	All metals are Trec unless otherwise noted.

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION:12 BASIN: **Upper Colorado River** Stream Segment Description	Desig	Classifications	NUMERIC STANDARDS PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			TEMPORARY MODIFICATIONS AND QUALIFIERS
6c. Mainstem of un-named tributary to Willow Creek from the Willow Creek Reservoir Rd (Sec. 8, T2N, R76W) to the confluence Willow Creek (Sec. 17, T2N, R76W).		Aq Life Cold 2 Recreation N Agriculture	T=TVS(CS-II)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=100	As(ac)=340 As(ch)=100(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS	Cu(ac/ch)=TVS Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
7a. All tributaries to the Colorado River, including all wetlands, from a point immediately above the confluence with the Blue River and Muddy Creek to a point immediately below the confluence with the Roaring Fork River, which are not on National Forest lands, except for specific listings in Segment 7b, 7c and in the Blue River, Eagle River, and Roaring Fork River basins.		Aq Life Cold 1 Recreation N Water Supply Agriculture	T=TVS(CS-II)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
7b. Mainstem of Muddy Creek, including all tributaries and wetlands, from the outlet of Wolford Mountain Reservoir to the confluence with the Colorado River; mainstems of Rock Creek, Deep Creek, Sheephorn Creek, Sweetwater Creek and the Piney River, including all tributaries and wetlands, from their sources to their confluences with the Colorado River, which are not on National Forest lands.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-I)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS(dis) Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	
7c. Mainstem of Muddy Creek from the source to a point immediately below the confluence with Eastern Gulch as well as all tributaries to and wetlands of Muddy Creek from the source to the outlet of Wolford Mountain Reservoir, except for listings in Segment 4. The mainstems of Derby, Blacktail, Cabin, and Red Dirt Creeks (all below Wolford Mountain Reservoir), including all tributaries and wetlands, from their sources to their confluences with the Colorado River, except for listings in Segment 4.		Aq Life Cold 1 Recreation N Water Supply Agriculture	T=TVS(CS-I)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=630/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
8. Mainstem of the Williams Fork River, including all tributaries and wetlands from the source to the confluence with the Colorado River, except for those tributaries listed in Segment 9.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-I)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100m	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrIII(ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS` Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	Point of compliance for Fe and Mn at Aspen Canyon Ranch well.
9. All tributaries to the Colorado and Fraser Rivers, including all wetlands, within the Never Summer, Indian Peaks, Byers, Vasquez, Eagles Nest and Flat Tops Wilderness Areas.	OW	Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-I)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
10a. Mainstem of the Fraser River from the source to a point immediately below the Rendezvous Bridge. All tributaries to the Fraser River, including wetlands, from the source to the confluence with the Colorado River, except for those tributaries included in Segment 9.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-I)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac-340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrIII(ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	
10b. Mainstem of the Fraser River from a point immediately below the Rendezvous Bridge to a point immediately below the Hammond Ditch.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-II)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrIII(ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	

STREAM CLASSIFICATIONS and WATER QUALITY STANDARDS

REGION:12 BASIN: **Upper Colorado River**	Desig	Classifications	NUMERIC STANDARDS						TEMPORARY MODIFICATIONS AND QUALIFIERS
Stream Segment Description			PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l			
10c. Mainstem of the Fraser River from a point immediately below the Hammond Ditch to the confluence with the Colorado River.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CS-II)°C D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrIII(ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac)=TVS Zn(ch)=TVS(sc)	
11. All lakes and reservoirs within Rocky Mountain National Park and within the Never Summer, Indian Peaks, Byers, Vasquez, Eagles Nest and Flat Tops Wilderness Areas.	OW	Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CL,CLL)°C D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	
12. Lakes and reservoirs within Arapahoe National Recreation Area, including Grand Lake, Shadow Mountain Lake and Lake Granby.		Aq Life Cold 1 Recreation E Water Supply Agriculture	T=TVS(CL,CLL)°C Shadow Mtn Res April-Dec $T_{(WAT)}$=19.30°C Granby Res April-Dec $T_{(WAT)}$=19.42°C D.O. = 6.0 mg/l D.O. (sp)=7.0 mg/l pH = 6.5-9.0 E.Coli=126/100ml	NH_3(ac/ch)=TVS Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=340 As(ch)=0.02(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ch)=WS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS	See * for narrative clarity standard. July through September Grand Lake Clarity =4 meter secchi disk depth, effective January 1, 2015.

*Narrative standard for Segment 12, Grand Lake: The highest level of clarity attainable, consistent with the exercise of established water rights and the protection of aquatic life.

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APPENDIX H: DETAILED LIST OF PLANT SPECIES WITH THE POTENTIAL TO OCCUR IN THE PROJECT AREA

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PLANT SPECIES AND MATERIAL IMPACTED BY GRAND DITCH BREACH 2003

ZONE 1

VASC	*Vaccinium scoparium*
PICO	*Pinus contorta*
ABBI	*Abies bifolia*
PIEN	*Picea engelmannii*
MARE[1]	*Mahonia repens*
JUCO[1]	*Juniperus communis*
ERPE[1]	*Erigeron peregrinus*
PYCH[1]	*Pyrola chlorantha*
ORSC[1]	*Orthilia securida*
ANMA[1]	*Anaphalis margaritacea*

ZONE 2

VASC	*Vaccinium scoparium*
SETR	*Enecio triangularis*
PIEN	*Picea engelmannii*
ABBI	*Abies bifolia*
BRAN	*Bromus anomalus*
RILA	*Ribes lacustre*
ANMA	*Anaphalis margaritacea*
ARCO1	*Arnica cordifolia*
ORSE1	*Orthilia secunda*
MIPE1	*Mitella pentandra*
ERPE1	*Erigeron peregrinus*
PSMO1	*Pseudocympterus montanus*
FRVI1	*Fragaria virginiana*
ACLA1	*Achillea lanulosa*
TRDU1	*Trapopogon dubius*
ANXX1	*Antennaria sp.*
TAXX1	*Taraxacum sp.*
GETX1	*Geranium sp.*
GAHU1	*Gaultheria humifusa*
ASTER1	*Aster sp.*

ZONE 3

VASC	*Vaccinium scoparium*
ORSE	*Orthilia secunda*
PIEN	*Picea engelmannii*
ABBI	*Abies bifolia*
PYRO	*Pyrola rotundifolia*
SAPL	*Salix planifolia*
ANMA1	*Anaphalis margaritacea*
ARCO1	*Arnica cordifolia*
VAMY1	*Vaccinium myrtillus*
RILA1	*Ribes lacustre*
DIIN1	*Distegia involucrata*
EQXX1	*Equisitum sp.*
CAAQ1	*Carex aquatilis*
CAUT1	*Carex utriculata*
JUXX	*Juncus sp.*
GRXX1	*Grass sp.*
MOXX	*Moss sp.*

ZONE 4

SAPL	*Salix planifolia*
CAAQ	*Carex aquatilis*
CAUT	*Carex utriculata*
PIEN	*Picea engelmannii*
PICO	*Pinus contorta*
MUMO1	*Muhlenbergia montana*
DECA1	*Deschampsia caespitosa*
FEXX1	*Festuca sp.*
CACA1	*Calamagrostis canadensis*
ANAR1	*Angelica arguta*
RICA1	*Ribes lacustre*
MOXX1	*Moss sp.*
FEXX1	*Fern sp.*
AGRO1	*Agrostis sp.*
PHAL1	*Phleum alpinum*

PHPR1	*Phleum pratense*
POXX1	*Poa sp.*
SETR1	*Senecio triangularis*
POBI1	*Polygonius bistortoides*
DRUN1	*Drepanocladus uncinatus*
POLX1	*Polytrichum sp.*
FRVE1	*Fradaria virginiana*
GEMA1	*Geum macrophyllum*
AGSC1	*Agrostiss scabra*
JUXX1	*Juncus sp.*
POLE1	*Polemonium sp.*
EPHO1	*Epilobium hornemanii*
LICH1	*Unknown Lichen*
ROCK	Varied rock substrate
BARE	Exposed soil without live or dead vegetation cover
LITT	Litter – Forest floor substrate made of decomposing vegetative matter providing several ecological services such as habitat for micro-organisms, soil erosion control, soil moisture retention, soil thermal insulation, soil nutrient recycling, and more.

[1] Plant species that were found within the 250 meter2 plots, but were not along the specific vegetation monitoring transects. These are species that were impacted, but not included in the analysis.

[*] All plant species indicated above are native to Rocky Mountain National Park.

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APPENDIX I: U.S. FISH AND WILDLIFE SERVICE LISTED SPECIES WITHIN ROCKY MOUNTAIN NATIONAL PARK

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ENDANGERED SPECIES ACT (ESA)
ENDANGERED, THREATENED, AND CANDIDATE SPECIES LIST
FOR
ROCKY MOUNTAIN NATIONAL PARK

Current as of March 15, 2013

The following table contains a list of species that are specific to Rocky Mountain National Park and are federally listed as endangered, threatened or candidates for listing by the U.S. Fish and Wildlife Service (USFWS) under the provisions of the Endangered Species Act (ESA).

The species that are included in the table must meet one of the following criteria:

1. The species is known to occur within the park.
2. The species does not occur within the park, but suitable habitat is available, the habitat is within the known elevation range for the species, and the species is known to exist in counties that the park occupies.
3. The species does not occur within the park, but actions within the park have the potential to affect the species.

In compliance with the ESA, all management actions within the park are evaluated to determine if they will have any effect on the species on this list.

Federally Listed and Candidate Species & Their Status in Colorado	**Known to Occur in RMNP**	**Known to Occur in Boulder County**	**Known to Occur in Larimer County**	**Known to Occur in Grand County**
Birds				
Least tern (interior population) *Sternula antillarum* Endangered	No ▲	▲	▲	No
Mexican spotted owl *Strix occidentalis lucida* Threatened	No	Yes Historically	Yes Historically	No
Piping plover *Charadrius melodus* Threatened	No ▲	▲	▲	No
Whooping crane *Grus Americana* Endangered	No ▲	▲	▲	No
Yellow-billed cuckoo *Coccyzus americanus* Candidate for Listing	Yes Historically	No	No	Yes
Fish				
Bonytail *Gila elegans* (presumed-historical) Endangered	No *	No	No	*
Colorado pikeminnow *Ptychocheilus lucius*	No *	No	No	*

Federally Listed and Candidate Species & Their Status in Colorado	Known to Occur in RMNP	Known to Occur in Boulder County	Known to Occur in Larimer County	Known to Occur in Grand County
Endangered				
Greenback cutthroat trout *Oncorhynchus clarki stomias* Threatened	Yes @	Yes	Yes	No
Humpback chub *Gila cypha* Endangered	No *	No	No	*
Pallid sturgeon *Scaphirhunchus albus* Endangered	No ▲	▲	▲	No
Razorback sucker *Xyrauchen texanus* Endangered	No *	No	No	*
Mammals				
Canada lynx *Lynx canadensis* Threatened	Yes	Yes	Yes	Yes
Preble's meadow jumping mouse *Zapus hudsonius preblei* Threatened	No ▲	Yes	Yes ©	No
North American wolverine *Gulo Gulo luscus* Proposed Threatened	Yes	Yes	Yes	Yes
Plants				
Colorado butterfly plant *Gaura neomexicana* spp. *Coloradensis* Threatened	No ▲	Yes ▲	Yes ▲	No
Ute ladies'-tresses orchid *Spiranthes diluvialis* Threatened	No ▲	Yes ▲	Yes ▲	No

TABLE TERMINOLOGY

*	Water depletions in the Upper Colorado River basin may affect these species and/or habitat in downstream reaches
▲	Water depletions in the South Platte River basin may affect these species and/or downstream reaches
©	There is designated critical habitat for the species within the county.
Candidate	Means there is sufficient information indicating that formal listing under the ESA may be appropriate
Endangered	Means the species could become extinct

Threatened	Means the species could become endangered
@	Due to recent genetic studies that are evaluating the greenback cutthroat trout and the Colorado River cutthroat trout, section 7 consultations will need to occur *for the interim* on select western slope streams containing cutthroat populations that appear to be greenback cutthroat trout, as based on genetic information. The FWS will provide a list of western slope streams selected for consultation; this list will be recommended by the Greenback Cutthroat Trout Recovery Team. Consultation on greenback cutthroat trout streams on the western slope is intended to be a temporary measure that provides protection of potential greenback cutthroat trout genetic material until this issue has been resolved.

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APPENDIX J: COLORADO DIVISION OF WILDLIFE STATE LISTED SPECIES WITHIN ROCKY MOUNTAIN NATIONAL PARK

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STATE ENDANGERED, THREATENED, AND RARE SPECIES FOR ROCKY MOUNTAIN NATIONAL PARK

LAST REVISED DECEMBER 2010

Rocky Mountain National Park uses the following table to identify state listed endangered and threatened species, species of concern and rare species that must be protected if found within a proposed project site. This list is periodically reviewed and updated. Federally listed species are maintained in a separate list.

Agencies have a variety of ways of tracking and measuring the biological imperilment of species. In April 2010 a Memorandum of Understanding was signed between the U.S. Fish and Wildlife Service and the National Park Service as a requirement under section 3 of Executive Order 13186. This Memorandum of Understanding concerns the responsibilities of the National Park Service to protect migratory birds and consider take or unintentional take in management actions. Rocky Mountain National Park's state endangered, threatened and rare species list includes birds of conservation concern that represent the highest conservation priorities for the southern Rocky Mountains.

Five primary categories are applicable to Rocky Mountain National Park:

STATE STATUS CODES

The Colorado Wildlife Commission determines if a species needs protection under state laws.

SE **State Endangered** – Listed as endangered by the Colorado Division of Wildlife. Those species or subspecies of native wildlife whose prospects for survival or recruitment within Colorado are in jeopardy, as determined by the Colorado Wildlife Commission. State endangered species have legal protection under Colorado Revised Statues 33-2-105 Article 2.

ST **State Threatened** – Listed as threatened by the Colorado Division of Wildlife. Those species or subspecies of native wildlife which, as determined by the Colorado Wildlife Commission, are not in immediate jeopardy of extinction but are vulnerable because they exist in such small numbers, are so extremely restricted in their range, or are experiencing such low recruitment or survival that they may become extinct. State threatened species have legal protection under Colorado Revised Statues 33-2-105 Article 2.

SC **State Special Concern** – Those species or subspecies of native wildlife that have been removed from the state threatened or endangered list within the last five years; are proposed for federal listing (or a federal listing "candidate species") and are not already state listed; have experienced, based on the best available data, a downward trend in numbers or distribution lasting at least five years that may lead to an endangered or threatened status; or are otherwise determined to be vulnerable in Colorado.

The Colorado Division of Wildlife maintains a list for SE, ST, and SC species at http://wildlife.state.co.us/wildlifespecies/speciesofconcern/

SPECIES OF CONTINENTAL IMPORTANCE

Partners in Flight developed a North American Landbird Conservation Plan in 2004 and an updated species assessment database and handbook in 2005. The "U.S. State of the Birds" report (2009) reveals troubling declines of bird populations during the past 40 years, which are also considered. These documents provide a continental synthesis of priorities, objectives and rankings that guide landbird conservation actions at national and international scales. A list of all Partners in Flight landbird species of continental importance, watch listed species, and stewardship species can be found at: http://www.rmbo.org/pif/pifdb.html.

Rocky Mountain National Park is within the Intermountain West Avifaunal Biome Bird Conservation Region BCR-16. Percent of breeding population ≥ 15% for each species are listed. Listed breeding populations in the intermountain region are within BCRs-16, 9 &10. Rocky Mountain National Park is within BCR-16.

CI **Continental Important Species** – Species must meet all of the following criteria in order to rank as a species of concern to be considered in RMNP management decisions

- o Population size (PS-g) score ≥ 3,
- o Breeding distribution (BD-g) score ≥ 3,
- o Threats to breeding (TB-g) score ≥ 3,
- o Population trend (PT-t) score greater than 2,
- o Percent of breeding population (Pct POP) in BCR-9, 10 & 16 ≥ 15%
- o Combined score TB+BD+PT+PS ≥ 12. The combined scores range from 4 for a relatively secure species to 20 for a species of highest concern.

U.S. FISH AND WILDLIFE SERVICE 2008 BIRDS OF CONSERVATION CONCERN

BCC The USFWS list of migratory and non-migratory birds of the United States and its territories is a list that are deemed to be the highest priority for conservation actions. The list is published and maintained by the U.S. fish and Wildlife Service's Division of Migratory Bird Management (www.fws.gov/migratorybirds)

ARAPAHO AND ROOSEVELT NATIONAL FORESTS RARE SPECIES

ARP 58% of RMNP's boundary is contiguous with lands administered by the U.S. Forest Service. 53% of the park boundary is contiguous with lands administered by the Arapaho and Roosevelt National Forests (ARP). ARP maintains a list of rare species identified by the Regional Forster for which population viability is a concern as evidenced by:

- o Significant current or predicted downward trends in population numbers or density
- o Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

GLOBAL AND STATE RANKING CODES

The Colorado Natural Heritage Program, based in Fort Collins, Colorado, manages a large database and ranking system for Colorado species. The database can be accessed through the Internet at: www.cnhp.colostate.edu.

The Colorado Natural Heritage Program ranking system has two primary components – a ranking for the global status of the specie (G), and a ranking for that part of the range found within the state (S). Numeric extensions are added to these on a scale of 1 (critically imperiled) to 5 (demonstrably secure). A reference that Colorado Natural Heritage Program uses to identify global status of a species is an online encyclopedia of life maintained by NatureServe at: http://www.natureserve.org/.

Natural Heritage ranks should not be interpreted as legal designations. Although most species protected under State or Federal endangered species laws are extremely rare, not all rare species receive legal protection. National Park Service policies and guidelines require the preservation and protection of all native species.

Global Rank Codes

G1 Critically imperiled globally because of rarity (5 or fewer occurrences in the world; or 1,000 or fewer individuals), or because of some factor of its biology makes it especially vulnerable to extinction.

G2 Imperiled globally because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range.

G3 Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).

G4 Apparently secure globally, though it might be quite rare in parts of its range, especially at the periphery, usually more than 100 occurrences and 10,000 individuals.

G5 Demonstrably secure globally, although it may be quite rare in parts of its range, especially at the periphery.

G#T# Trinomial rank (T) is used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.

GQ Indicates uncertainty about taxonomic status.

G#? Indicates uncertainty about an assigned global rank.

State Rank Codes

S1 Critically imperiled in the state because of rarity (5 or fewer occurrences; or 1,000 or fewer individuals), or because of some factor of its biology makes it especially vulnerable to extinction.

S2 Imperiled in the state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range.

S3 Vulnerable throughout its range within a state or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).

S4 Apparently secure within the state, though it might be quite rare in parts of its range, especially at the periphery, usually more than 100 occurrences and 10,000 individuals.

S5 Demonstrably secure within the state, although it may be quite rare in parts of its range, especially at the periphery.

S#B Refers to the breeding season imperilment of species that are not permanent residents.

S#N Refers to the non-breeding season imperilment of species that are not permanent residents. Where no consistent location can be discerned for migrants or non-breeding populations, a rank of SZN is used.

SH Historically known, but usually not verified for an extended period of time and could be extirpated from the park or the state.

SNR Not yet ranked in the state due to lack of information.

SX Presumed extirpated from within the state.

S#? Indicates uncertainty about an assigned state rank.

The RMNP list of state listed Endangered, Threatened, and Rare Species does not include Global Rank Codes G4 or G5 or State Rank Codes S4 and S5 because these rankings indicate that the specie is apparently or demonstrably secure. However, the RMNP list does include species of continental concern (CI), ARP species of concern, or state special concern (SC). If a specie is listed as unconfirmed it means it occurred historically and is presently not confirmed in the park; or has never been confirmed but the park has appropriate habitat; or it has been confirmed (historically or presently) in the counties the park occupies.

Scientific Name	Common Name	Time of Occurrence in RMNP	State Status	CNHP, ARP, CI, BCC Rank	
				Global	State
Amphibians					
Bufo boreas pop1	Boreal toad (Southern Rocky Mountain Population)	All year	SE	G4T1Q	S1
Rana sylvatica	Wood frog	All year	SC	G5	ARP, S3
Reptiles					
Thamnophis sirtalis	Common garter snake	All year	SC	G5	SNR
Birds					
Aquila chrysaetos	Golden eagle	All year			BCC
Falco mexicanus	Prairie falcon	Summer or migrant		G5	S4/3, S4N, BCC
Accipiter gentiles	Northern goshawk	All year		G5	ARP, S3B
Buteo swainsoni 15% breeding population in intermountain west	Swainson's hawk	Migrant		CI, G5	SNR
Aegolius funereus	Boreal owl	All year		G5	ARP, S2

Scientific Name	Common Name	Time of Occurrence in RMNP	State Status	CNHP, ARP, CI, BCC Rank	
				Global	State
Otus flammeolus 40% breeding population in intermountain west	Flammulated owl	Summer or migrant		CI, G4	S4, BCC
Amphispiza belli 83% breeding population in intermountain west	Sage sparrow	Summer or migrant		CI, G5	ARP, S3B
Spizella breweri 94% breeding population in intermountain west	Brewer's sparrow	Summer or migrant		CI, G5	SNR, BCC
Bucephala islandica	Barrow's goldeneye	Winter or migrant	SC	G5	S2B
Buteo regalis	Ferruginous hawk	Migrant	SC	G4	ARP, BCC, S3B, S4N
Calcarius mccownii 21% breeding population in intermountain west	McCown's longspur	Migrant		G4	ARP, S2B
Catharus fuscescens	Veery	Summer or migrant		G5	S3B, BCC
Pipilo chlorurus 92% breeding population in intermountain west	Green-tailed towhee	Summer		CI, G5	S5
Catoptrophorus semipalnatus	Willet	Migrant		G5	S1B
Sphyrapicus nuchalis 95% breeding population in intermountain west	Red-naped sapsucker	Summer		CI, G5	
Melanerpes lewis 87% breeding population in intermountain west	Lewis's woodpecker	Summer, migrant		CI, G4	ARP, S4, BCC
Sphyrapicus thyroideus 87% breeding population in intermountain west	Williamson's sapsucker	Summer		CI, G5	S4B
Coccyzus americanus occidentalis (currently considered unconfirmed)	Western yellow-billed cuckoo	Accidental, two recorded occurrences, 1947 & 1980	SC	G5T3Q	SNR, BCC
Contopus cooperi 21% breeding population in intermountain west	Olive-sided flycatcher	Summer		CI, G4	SNR
Empidonax oberholseri 86% breeding population in intermountain west	Dusky flycatcher	Summer		CI, G5	S5B

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Selasphorus rufus 36% breeding population in intermountain west	Rufous hummingbird	Migrant		CI, G5	SNR
Stellula calliope 95% breeding population in intermountain west	Calliope hummingbird	Summer		CI, G5	SNR
Cypseloides niger 29% breeding population in intermountain west	Black swift	Summer		CI, G4	ARP, S3B
Cypseloides niger 38% breeding population in intermountain west	White-throated swift	Summer		CI, G5	SNR
Anthus spragueii	Sprague's pipit	Accidental migrant, one recorded occurrence, 1980 LuLu City		CI	SNR
Vermivora virginiae 62% breeding population in intermountain west	Virginia's warbler	Summer		CI, G5	S5
Dendroica graciae 14% breeding population in intermountain west	Grace's warbler	Accidental, one recorded occurrence, 1990		CI, G5	S3B, BCC
Dolichonyx oryzivorus	Bobolink	Accidental, summer or migrant		G5	S3B
Egretta thula	Snowy egret	Migrant or rare summer		G5	S2B
Falco peregrinus anatum	American peregrine falcon	Summer or migrant	SC	G4T3	ARP, BCC, S2B
Glaucidium gnoma	Northern pygmy owl	All year		G5	S3B
Grus canadensis tabida	Greater sandhill crane	Summer or migrant	SC	G5T4	S2B, S4N
Haliaeetus leucocephalus	Bald eagle	All year	ST	G5	ARP, S1B, S3N, BCC
Leucosticte australis 100% breeding population in intermountain west	Brown-capped rosy-finch	All year		CI, G4	S3B, S4N, BCC
Leucosticte atrata 100% of breeding population in intermountain west	Black-rosy finch	Irregular visitor in the winter		CI, G4	SNR, BCC
Loxia leucoptera	White-winged crossbill	All year, Irreg-ular visitor		G5	S1B

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Carpodacus cassinii 86% breeding population in intermountain west	Cassin's finch	All year		CI, G5	ARP, SNR, BCC
Numenius americanus	Long-billed curlew	Migrant	SC	G5	ARP, S2B, BCC
Pelecanus erythrorhynchos	American white pelican	Migrant		G3	S1B
Plegadis chihi	White-faced ibis	Migrant		G5	S2B
Seiurus aurocapillus	Ovenbird	Rare summer or rare migrant		G5	S2B
Sterna forsteri	Forster's tern	Migrant		G5	S2B, S4N
Strix occidentalis lucida surveys in 2007 and 2008 did not find this owl in the park. 20% breeding population in the intermountain west	*Mexican spotted owl	Most likely if it ever occurred in the park it would be late summer	ST	CI, G3T3,	S1B, SUN
Fish					
Oncorhynchus clarki pleuriticus	Colorado River cutthroat trout	All year	SC	G4T3	ARP, S3
Oncorhynchus clarki stomias	Greenback cutthroat trout	All year	ST	G4T2T3	S2
Mammals					
Canis lupis historic/presently unconfirmed in RMNP	Gray wolf		SE	G4	S1
Lynx canadensis Confirmed sightings in the park in recent years	Lynx	All year	SE	G5	ARP, S1
Gulo gulo historic/ confirmed sighting 2009	Wolverine	All year	SE	G4	ARP, S1
Lontra Canadensis Colorado River watershed but a few sightings in the Big Thompson River	River otter	All year	ST	G5	ARP
Sorex hoyi montanus	Pygmy shrew	All year		G5T2 T3	ARP, S2
Sorex nanus	Dwarf shrew	All year		G4	S2
Ursus arctos (historic/extirpated)	Grizzly or brown bear		SE	G4	SX
Invertebrates (Insects)					
Alloperia pilosa	A stonefly	All year		G3	S2
Colorado luski	Lusk's pinemoth	Summer		G4	S1?
Hyles galli	Galium sphinx moth	Summer		G5	S3?

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Paratrytone snowi	Snow's skipper	Summer		G5	S3
Perlomyia utahensis	A stonefly	All year		G3	S2
Pictetiella expansa	A stonefly	All year		G3	S2
Pyrgus ruralis	Two-banded skipper	Summer		G5	S3
Stinga morrisoni	Morrison's skipper	Summer		G4G5	S3S4
Mollusk					
Acroloxus coloradensis	Rocky mountain capshell	All year	SC	G3	ARP, S1
Lichens					
Bryoerythrophyllum ferruginascens				G3G4	S1S3
Bryum alpinum				G4G5	S1S3
Mosses					
Andreaea heinemannii				G3G5	S1S3
Andreaea rupestris				G5	S1S3
Aulacomnium palustre var. imbricatum				G5TNR	S1S3
Campylopus schimperi				G3G4	S1S3
Grimmia mollis				G3G5	S1S3
Grimmia teretinervis				G3G5	S1S3
Hylocmiastrum pyrenaicum				G4G5	S1S3
Hylocomium alaskanum				G5	S1S3
Leptopterigynandrum austro-alpinum				G3G5	S1S3
Mnium blyttii				G5	S1S3
Oreas martiana				G5?	S1S3
Plagiothecium cavifolium				G5	S1S3
Pleurozium schreberi	Feathermoss			G5	S1S3
Pohila tundrae				G2G3	S1S3
Rhytidium rugosum	Golden glade-moss			G5	S1S3
Roellia roellii				G4	S1S3
Sphagnum contortum	Sphagnum			G5	S1S3
Sphagnum angustifolium				G5	ARP, S2
Liverworts					
Gymnomitrion corallioides				G4G5	S1S3
Nardia geoscyphus				G5	S1S3
Plants					
Agrostis idahoensis	Bentgrass				ARP
Aletes humilis (unconfirmed)	Larimer aletes			G2G3	ARP, S2S3

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Aquilegia saximontana	Rocky Mountain columbine			G3	S3
Asplenium septentrionale	Grass-fern			G4G5	ARP, S3S4
Artemisia pattersonii	Patterson's wormwood			G3G4	S3
Asplenium septentrionale	Grass-fern			G4G5	S3S4
Botrychium echo	Reflected moonwort			G3	S3
Botrychium furcatum Not yet fully described	Fork leaf moonwort			G1G2	S1S2
Botrychium hesperium	Western moonwort			G4	S2
Botrychium lanceolatum var lanceolatum	Lance-leaved moonwort			G5T4	S3
Botrychium lunaria	Common Moonwort			G5	S3
Botrychium minganense	Mingan's moonwort			G4	S1
Botrychium pinnatum	Northern moonwort			G4?	S1
Botrychium 'redbank' Not yet fully described	Redbank moonwort			G2G3	S3
Carex diandra	Lesser panicled sedge			G5	ARP, S1
Carex leptalea	Bristle-stalk sedge			G5	ARP, S1
Carex limosa	Mud sedge			G5	ARP, S2
Carex oreocharis	A sedge			G3	S1
Carex stenoptila	River bank sedge			G2	S2
Castilleja puberula	Downy Indian-paintbrush			G2G3	S2S3
Chionophila jamesii	Rocky mountain snowlover			G4?	S3S4
Chrysosplenium tetrandrum	Golden saxifrage				ARP
Corallorhiza westeriana					ARP
Cyripedium fasciculatum	Clustered lady's-slipper			G4	ARP, S3
Cystopteris montana	Mountain bladder fern			G5	ARP, S1
Draba crassa	Thick-leaf whitlow-grass			G3	S3
Draba fladnizensis	Arctic Draba			G4	S2S3
Draba grayana	Gray's Peak whitlow-grass			G2	ARP, S2

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Draba porsildii	Porsild's whitlow-grass			G3G4	S1
Draba streptobrachia	Colorado Divide whitlow-grass			G3	S3
Dryopteris expansa	Spreading wood fern			G5	S1
Erocallis triphylla	Dwarf spring Beauty			G4?	S2
Goodyera oblongifolia					ARP
Hippochaete variegata	Variegated scouringrush			G5	S1
Juncus tweedyi	Tweedy rush			G3Q	S1
Juncus vaseyi	Vasey bulrush			G5?	S1
Lewisia rediviva	Bitteroot			G5	S2
Liatris ligulistylis	Gay-feather			G5?	S1S2
Lilium philadelphicum	Wood lily			G5	ARP, S3S4
Listera borealis	Northern twayblade			G4	ARP, S2
Listera convallarioides	Broad-leaved twayblade			G5	ARP, S2
Luzula subcapitata	Colorado wood-rush			G3?	S3?
Lycopodium annotinum					ARP
Mentzelia sinuata	Wavy-leaf stickleaf			G3	ARP, S2
Menyanthes trifoliata					ARP
Mimulus gemmiparus	Weber monkey flower			G1	S1
Papaver Kluanense	Alpine poppy			G5T3 T4	S3S4
Parnassia kotzebuei	Kotzebue grass-of-parnassus			G5	ARP, S2
Penstemon harbourii	Harbour beardtongue			G3G4	S3S4
Polypodium hesperium	Western polypody			G5	S1S2
Ploypodium saximontanum				G3?	ARP, S3?
Potentilla ambigens	Southern Rocky Mountain cinquefoil			G3	ARP, S1S2
Potentilla rupincola	Rocky Mountain cinquefoil			G2	ARP, S2
Pyrola picta (unconfirmed)	Pictureleaf wintergreen			G4G5	S3S4

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Salix serissima	Autumn willow			G4	ARP, S1
Sisyrinchium pallidum	Pale blue-eyed grass			G2G3	S2
Telesonix jamesii	James' telesonix			G2	S2
Tonestus lyallii	Lyall haplopappus			G5	S1?
Viola Selkirkii	Selkirk violet			G5?	ARP, S1

*There are no historic records of the Mexican spotted owl in the park. Surveys by Rocky Mountain Bird Observatory in 2007 and 2008 found no Mexican spotted owls in the park, but RMNP, with concurrence from the US Fish and Wildlife Service, identified and manages potential habitat due to historic records of the owl occurring in Boulder and Larimer Counties at lower elevations. There are no recent observations of the owl in these two counties.

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